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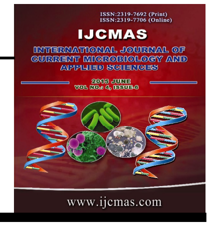

Original Research Article

The Need for Improved BPA Testing and Awareness among Stakeholders in Underdeveloped Countries: A Jamaican Pilot Study

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A B S T R A C T

Despite the global rise in concern of the harmful effect of Bisphenol A (BPA), the lack of implementation for: screening analysis, future strategies for reduced concentration and education of the general populous in selected countries is alarming. Many developed countries including the USA, Canada and Europe through various organizations: United States Environmental and Protection Agency, World Health Organization and Joint Food and Agriculture organization are actively implementing policies to address this growing concern. While, under-developed countries like Jamaica is still behind in such awareness much less policy implementation. This research reports for the first time, quantitative and qualitative analysis of BPA, achieved through a cross-sectional analytical study of treatment plants and bottled water and interviews with relevant stakeholder srespectively. BPA's detection in all the brands of bottled water sampled using LC-MS, ranged between 12.9 – 56.7 ng/ L while ranges for the raw and untreated were 4.86 – 21.60 ng/ L and treated, 6.86 – 14.84 ng/ L on the date of sampling. Ninety percent of the stakeholders were unaware of BPA and its effects and currently had no plans for future testing. These data indicate the need for policy implementation of BPA's awareness, minimization and alternate uses among the Jamaican populous.

Keywords

Policy makers, Bottled water, Treated water, Raw water, Polycarbonate plastic, Tolerable daily intake

Introduction

Governments are appointed by the people as managers of their countries. Among their roles are, protecting the security of state, public citizens and environment in addition to economic management. Crucial to these execution are detailed protocols that engage relevant individuals and organizational bodies. To this end, policy design and implementation are pivotal, which have to be intertwined with existing trends and technology.

BPA is currently a global cause of concern given its proven harmful effect to the human health. BPA, the building block of plastic polymers like, epoxy resins and polycarbonates is used to make bottles for beverages used by adults and babies (Canada Gazette, 2010), and also in the lining of cans and plastic packages of processed foods. Given its diffusible capacity, BPA has been shown to leach into contained beverages and foods where leached amounts parallel environmental temperatures, in that, higher temperatures favored increased amounts of leached BPA in food items(Bae, Jeong *et al.* 2002). Daniel Zalko and colleagues at the French National Institute for Agricultural Research in Paris, used radioactively labeled BPA and observed that approximately 46% of BPA diffused through human skin and also that BPA was metabolized there (Zalko *et al.*, 2011).

In addition, BPA has been shown to enter surface and ground water from plastic or other containers in landfills and through sewage treatment plant effluent, and so can enter domestic water supply. This is confirmed by Barnes and his team where concentrations of BPA were detected at 60 ng/ L in the Mississippi River surface water samples (Barnes *et al.*, 2002). While, Ruthann Rudel and colleagues studied the occurrence of BPA and other estrogenic compounds in ground and sewage water in Cape Cod, Massachusetts (Rudel *et al.*, 1998). They detected BPA in septage and waste water at 1 μg/L concentrations. They also detected BPA in some drinking water wells at concentrations ranging from below the quantitation limit to 32.9 μg/L.

It therefore means that as humans, there are numerous conduits of possible contact with BPA, a full awareness of these and BPA's pathophysiological effects can curtail our contact points. *In vitro* and *in vivo* studies have demonstrated the capacity of BPAto behave like an endocrine disrupter. Therefore, it mimics hormones such as estrogen and insulin and thus interferes with reproductive and metabolic processes. It is postulated that BPA may cause defects in fetal development (US Environmental Protection Agency 2009), therefore, it is classified by the United States Environmental Protection Agency (U.S. EPA) as a "reproductive, developmental and systematic toxicant" (US Environmental Protection Agency, 2009). BPA is also associated with other conditions such as: arthritis, cancer, cardiovascular disease, diabetes, liver disease, respiratory disease, stroke and thyroid disease (Lang *et al.*, 2008).

Given these confirmed unideal biological effects of BPA, the United States EPA has partnered with the Food and Drug Administration (FDA), the Centers for Disease Control and Prevention (CDC), and the National Institute of Environmental Health Sciences (NIEHS) to better determine and evaluate the potential health consequences of BPA. The results of this assessment work will factor significantly in any future EPA decisions to address potential risks to human health resulting from uses within EPA's jurisdiction (US Environmental Protection Agency, 2009) (U.S. EPA, 2010). So far, the FDA declared in 2012 that baby bottles and children's drinking cups could no longer contain BPA (Tavernise, 2012), an action the European Union is also taking. Meanwhile, Canada has decided that the evidence linking BPA to human health are sufficient for BPA to be listed as harmful to human life and be added to Schedule 1 of the Canadian Environmental Protection Act (Canada Gazette, 2010).

There remains much to be understood about BPA, but what is currently known is sufficient to guide policy makers through relevant stakeholders to firstly, educate the general populous, secondly, implement measures for proper testing of the various conduits for BPA and human contact, and thirdly, identifying and regulating the use of more appropriate alternatives, the lack of awareness of key Jamaican stakeholders to BPA's effects and need for screening, hence this research, for the first time interviewed these stakeholders of the relevance of BPA in addition to testing BPA's levels in bottled water, untreated and treated water. Though the levels reported are less than the yard stick used (Willhite *et al.,* 2008) for biological significance, they do not reflect the total daily BPA levels among the Jamaican populous. Given the association of BPA to the previously named lifestyle diseases and its current lack of awareness among relevant Jamaican stakeholders, it is therefore no surprise when it is reported that chronic diseases account for 50% of disease burden in many developing countries. It is predicted that such diseases will cost these countries $84 billion dollars by this year (Nugent, 2008). It is hoped that the findings from this research will propel a greater need to educate the Jamaican people and by extension the Caribbean and other underdeveloped countries of BPA while strategizing the best way forward. This we believe will be one of the measures to enforce some amount of proactivity to the lifestyle disease burden faced by Jamaica (Ferguson *et al.,* 2011) and the many other developing countries (Nugent, 2008), as measures can be enforced to reduce our incidences and subsequently mortality rates while saving minimizing the financial encumbrance of these countries.

Materials and Methods

Quantitative component

Study design for bottled water analysis

A cross-sectional analytical study was conducted to establish the concentration of BPAin a sample of potable bottled water.

Population of bottled water

The population included all 51 brands of bottled water sold in Jamaica as obtained from the Information Services Office at the Bureau of Standards Jamaica.

Sample size of bottled water

The number of brands calculated to be 34 was sampled from the population and determined using a statistical formula (no $=[t^2 s^2] / d^2$) with a confidence level of 95%, error level of 0.05 and response rate of 100%. The standard deviation and precision used to calculate the sample size were derived from previous studies in the literature (Li *et al.,* 2010).

Sampling technique for bottled water

After the sample size was determined the brands were selected using a table of random numbers (Million Random Digits, 1995). To ensure that each brand in the population had an equal and independent chance of selection, brands were assigned numbers 1 to 51 and the randomly selected numbers constituted the sample.

The potable bottled water brands in the sample were purchased from supermarkets in the Half Way Tree, Liguanea and Cross Roads areas of Kingston and St. Andrew.

Inclusive criteria for bottled water

All potable bottled water brands sold in Jamaica.

Bottled water in containers made from plastic.

Exclusive criteria for bottled water

Potable bottled water not sold in Jamaica.

Bottled water in containers made from material other than plastic.

Environmental water sampling

Due to financial and time constraints repeat sampling over a period of time could not be done. Each location was sampled once for this study. However, the stability of BPA and its solubility in water (0.3 g/L) should help to mitigate the limitation from the inadequate sampling.

Sites:

1. Mona treatment plant –inflows of Hope and Yallas rivers, reservoir and treated water
2. Hope treatment plant – Hope River inflow, reservoir and treated water
3. Constant Spring treatment plant – Raw water source, reservoir and treated water
4. Ferry treatment plant – treated water

Protocol:

3 x 200 mL water collected in BPA free amber bottles.

Laboratory measurements

Sample treatment:

Raw and treated water samples from NWC facilities were adjusted to pH 2 with concentrated Hydrochloric Acid at the Tropical Medicine Research Institute (TMRI) laboratory and stored frozen. The frozen samples and bottled water samples were shipped to Loyola University (Department of Preventive Medicine and Epidemiology), Maywood, Illinois, and USA, where they were analyzed for BPA.

BPA extraction:

Water samples (50 mL) were treated with β – glucoronidase/sulfatase enzyme to generate the free phenol. A solution of internal standard, isotopically-labelled BPA (Bisphenol A-d_{16}), was spiked into the samples at a known concentration to permit quantification and the mixture was then diluted with a 0.1 M formic acid solution. The enzyme digest containing the stable isotope labeled internal standard was heated in a water bath for about 12 hours at 37°C.BPA was extracted from the digest using Solid Phase Extraction (SPE) cartridges (Oasis HLB, 1.8 mL/ 10 mg, Waters Corporation, Milford, MA, USA) and eluted with a mixture of methanol and acetonitrile. The extract was dried under vacuum and then reconstituted in 60:40 water and acetonitrile mixture (300 uL).

Method of analysis:

All samples in the study were analyzed for BPA content by isotope dilution using liquid chromatography tandem mass spectrometry

(LC-MS/MS) method. 20 uL of the reconstituted samples were injected into an Agilent 1290 UPLC. Separations were done on a Waters BEH C18 column (2.1×100 mm, 1.7 μm, Waters Corporation, Milford, MA, USA) with water (A) and acetonitrile (B) as solvents: 60% B for 2 min, followed by a linear gradient to 80% B within 20 min. The solvent composition was then kept at 80% B for 2 min; flow rate was 300 uL/min. Detection was done by MS analysis carried out in the negative ion mode using an Agilent model 6460 triple quadrupole mass spectrometer equipped with an electrospray ionization source. The (M-H) ions formed in the source of the MS underwent loss of a phenol molecule predominantly upon collision activation.

Limit of detection (LOD):

Instrument detection limit for BPA was 800 ng/ L.

Calculations

Variables:

Concentration of internal standard in sample = 11.2 ng/ mL
Peak area of internal standard in sample = 409
Peak area of BPA in sample = 70

Sample calculation

$$\frac{\text{A area}}{\text{IS area}} = \frac{\text{A conc}}{\text{IS conc}}$$

Therefore:

$$\text{A conc} = \frac{\text{A area} \times \text{IS conc}}{\text{IS area}}$$

Key:
A – analyte
IS – internal standard

$$\text{A conc} = \frac{70 \times 11.2}{409}$$

$$= 1.9169$$

Therefore, analyzed BPA concentration = 1.9169 ng/ mL

Volume reconstituted = 300 uL = 0.3 mL
That is, 1 mL contains 1.9169 ng BPA
Then 0.3 mL contain 0.3 x 1.9169 = 0.5751 ng
Mass of BPA in reconstituted volume = 0.5751 ng

Volume of water sample processed = 50 mL
Since reconstituted volume was prepared with BPA extracted from 50 mL water
Then BPA in 50 mL sample = 0.5751 ng

Concentration of BPA in sample = mass/ volume

= 0.5751 ng/ 50 mL

= 0.0115 ng/ mL

= 11.5 ng/ L

Qualitative component

Relevant officials from the National Water Commission (NWC), National Environment and Planning Agency (NEPA), Ministry of Health (MOH) and Bureau of Standards Jamaica (BSJ) were interviewed. Due to ethical considerations the identities of persons interviewed is not disclosed.

Process of selecting participants

Institutions that have authority and responsibility for environmental and commodity monitoring and assessment in Jamaica were selected for the qualitative component of this study. Persons in these institutions who by nature of their positions should be the most knowledgeable on the subject were selected as interview participants.

Participants selected

- The NWC is the major supplier of potable water in Kingston and St. Andrew from dams supplied from rivers. Daily water samples are collected by the NWC and tested at its laboratories for nutrients, minerals, chlorates, coliform bacteria and turbidity.
- The MOH is the country's health authority and does routine monitoring of bottled water for coliform bacteria and of raw and treated water for chlorine, nitrates and alkalinity.
- NEPA is an executive agency mandated to promote sustainable development by ensuring protection of the environment and orderly development in Jamaica. Routine monitoring of nutrients and coliform bacteria in fresh water is performed by NEPA.
- BSJ is a statutory body established to promote and encourage standardization in relation to commodities, processes and practices. Routine testing of bottled drinking water sold in Jamaica is done for nutrients, chlorates, heavy metals, minerals and coliform bacteria.

Data collection

The researcher conducted all interviews using an interview guide (Appendix I) and the results of these can be viewed in figure 1.

Data analysis for qualitative component

Responses were collated and analyzed by identifying themes and interpreting the main ideas. Findings were reported as described by the participants. From the responses a deduction was made on the likelihood that potable water in Kingston and urban St. Andrew will be tested for BPA in the near future.

Results and Discussion

The first aspect to this project involved the testing of water from treatment plants and bottled water to identify the BPA levels from that point. The NWC supplies potable water to Kingston and Urban St. Andrew from the Ferry, Hope, Constant Spring, and Mona Treatment plants (Table 1). The Ferry treatment plant located on the Mandela Highway is supplied with partially treated water from wells in Bog Walk, Cross Pen and Waterloo areas in St. Catherine. Due to the remote location of these wells no raw water was sampled for this treatment plant. However, BPA concentration of 18.84 ng/ L was determined on the date of sampling as shown in table 1.

The 4 NWC, treatment plants (Ferry, Hope, Constant Spring and Mona) were tested for BPA's concentration at various points: post treatment, inflow and reservoir. Overall, post treatment seemed to be less than inflows except for the Mona treatment plant that has two avenues of inflow and one, the Yallas river inflow was lower than post treatment. The Constant Spring Treatment plant recorded the highest BPA's concentration at its Constant Spring inflow at 21.6ng/L. Overall, the levels of BPA ranged between 4.69-21.6ng/L as seen in table 1.

While the treated outflow from the NWC treatment plants showed a reduction in BPA compared to the inflow water, BPA's levels in reservoirs of the treatment plants were inconsistent. This could have been due to pretreatment, such as, chlorination at the Hope and filtration and turbidity elimination at the Constant Spring plants. At the Mona reservoir where there were no pretreatments, the reduction of BPA compared to inflow could have been due to non-uniform BPA concentrations across the large reservoir. Variations in BPA concentrations could have been based on time of sampling and location of sampling (different depth, slightly different locations, etc.). This variation could have also explained the reduced levels of BPA in the reservoirs from the other two treatment plants.

Using The Wilcoxon Signed Rank test (95 % CL), the reduction in BPA concentration in treated outflow compared to inflow water wasnot statistically significant (Table 2). The Wilcoxon Signed Rank test is a nonparametric statistical test used to determine statistical difference in two related samples. In this case the Wilcoxon Signed Rank test showed the general trend of BPA concentration in the treated and raw water from the three treatment plants. The asymptotic significance (2-tailed) value which represents the p-value = 0.285 is greater than 0.05. Therefore, the null hypothesis, inflow and outflow water is equal, cannot be rejected and it can be concluded that the treatment did not reduce the BPA concentration in water ($p = 0.285$). A nonparametric test was used because the number of observations (samples) was too small to assess adequately a normal distribution.

From a total of 51 brands of bottled water sold in Jamaica according to the Bureau of Standards Jamaica, a sample of 36 brands were identified using the literature and statistical calculation taking into account a response rate of 100 % and confidence level of 95 %. From this sample only 14 were found in the supermarkets visited in Kingston and urban St. Andrew. These 14 brands from local and abroad demonstrated an average BPA value of 26.8ng/L (Figure 2). Of the 14 brands, 5 were imported and the remaining 9, local (Figure 3). MiVida, the local brand reported the highest concentration of BPA at 56.7ng/L followed by Grace with 39.4ng/L while Tropical Blue, the local brand reported the lowest concentration at 12.9ng/L among all brands. Fiji, exhibited the highest concentration of BPA among the imported brands, with a value of 38.3ng/L. Of the 14 bottled waters, 5 were purified and 9 were spring water (Figure 4). The average BPA among the spring water was lower than the purified water, 22.42 vs. 34.7ng/L. However, based on the Mann-Whitney U test (95 % CL) there is no statistically significant evidence that BPA in the locally produced and imported bottled water sampled is different ($p = 0.841$).

Unlike polycarbonate (PC) plastic, PET plastic is not made from BPA and is expected to be BPA free. However, BPA was found in the brands of bottled water sampled. This finding is supported by other studies. For example, BPA concentration ranging from 17.6 to 324 ng/ L was found in a study of twenty brands of PET bottled water in the city of Guangzhou in China (Li *et al.*, 2010). Similar trends were observed for Catalonia, Spain where BPA concentration increase from below limit of detection in most samples to concentrations ranging from 8 to 11 ng/ L after 10 weeks of storage at room temperature (Casajuana and Lacorte, 2003). On the other hand, in a study conducted in Canada, 38 brands of bottled water in PET plastic container tested for BPA were all below the method detection limit of 0.5 ug/ L (Cao and Corriveau, 2008). It should be taken into consideration that the source of organic pollutants in bottled water is attributed mainly to (i) compounds which are directly present in the aquifer as contaminants; (ii) external contamination from the bottling plant and (iii) migration from containers, especially during storage (Casajuana and Lacorte, 2003).

Therefore, there is a strong possibility that the BPA present in the water in PET plastic containers are from the water itself. Depending on the type of purification and pipes/tubing the water goes through there is the possibility that it might pick up BPA there. Also, it is possible that the PET plastic containers were molded in facilities that also produce PC plastic containers.

Water from springs may be contaminated with BPA leached into aquifers from plastic waste. Reverse osmosis is used by many bottling companies to produce purified water. This process uses a series of filtration and ion exchange resin cartridges. These cartridges contain plastic materials such as polyolefin, polypropylene, and polyethylene. The water purification systems also contain numerous plastic tubes, tanks, hose, o-rings and washes. All these agents result in BPA contamination of purified bottled water.

Estimating the magnitude of the potential dose of toxins from water ingestion requires information on the quantity of water consumed. There was no information available on the average consumption of bottled water per day in Jamaica from relevant authorities and market research. However, the daily intake of BPA was estimated by using the quantity of consumed drinking water according to the U.S. EPA. The U.S. EPA traditionally estimates the rate of drinking water consumption to be 2 L per day for adults (60 kg body weight) and 1 L per day for infants (10 kg body weight) (Li *et al.*, 2010).

The estimation was performed using the average BPA concentration in the fourteen bottled water and outflow water at the four NWC treatment plants on the day of sampling under two conditions. Firstly, if the entire water intake came from bottled water, an adult (60 kg body weight) would ingest 53.6 ng/ day of BPA and an infant (10 kg body weight) would ingest 26.8 ng/ day. Secondly, if the entire water intake came from tap water, an adult (60 kg body weight) would ingest 19.26 ng/day of BPA and an infant (10 kg body weight) would ingest 9.63 ng/ day.

Using this scenario, daily intake of BPA through consuming only tap water and bottled water was two times more than consumed by infants. However, adults are exposed to BPA through many other conduits which could make their total daily BPA intake much more and though the tested levels here are much less than what is thought to be of concern (Willhite *et al.*, 2008) there needs to be an island wide testing of BPA to assess a more accurate value of approximate total BPA levels consumed across the Jamaican populous. Also, some infants may still be fed from baby bottles made from PC plastics. It is shown that because of BPA leaching from PC baby bottles, BPA in water ingested by infants can be up to three times more than adults (Li *et al.*, 2010). This raises serious concerns because infants are more vulnerable to exposure to toxic substances.

More extensive sampling was needed of the NWC treated and untreated water plants in addition to the bottled waters. This would not only provide more precise values, but would also shed light into more accurate daily intake of BPA given other variables such as storage and temperature. It is indeed confirmed that longer storage at room temperatures parallel an increase in BPA levels much less at elevated temperatures (Amiridou and Voutsa 2011). Given the tropical nature of Jamaica and our all year round high temperatures, how are the bottled waters transported to the retailors and when they get there for how long are they stored?

When a consumer purchases these bottled waters, how do they store them at home how and for how long before they consume? All these and more would have given more accurate values into daily BPA's intake. Yet, there are so many other avenues for BPA consumption such as in foods.

The other limitation was the inability to use the field blank water, produced by Millipore water purification system as it was not analyte free. Field blanks for water samples usually consist of deionized water in capped and cleaned containers carried to the sampling site and exposed to the sampling environment. The absence of field blanks is a limitation as possible contaminations of the water from the sampling environment could not be measured and accounted for.

Six critical points were highlighted from the interviews conducted comprising of 10 questions with appropriate stakeholders (Fig. 1). Eighty percent were not knowledgeable about BPA and 0% conducted past and current evaluations on BPA's levels in bottled water and at treatment plants. Currently, there are no discussions about BPA's monitoring nor plans for future screening. When asked, "What would cause the institution to start monitoring BPA," the following answers were given:

- Two persons gave similar responses, "Evidence of over exposure in domestic water. Evidence of effects in human;"
- "Evidence of over exposure in domestic water. Evidence of effects in human
- "Outcomes in population traceable to domestic or bottled water. Recommended by WHO due to global trend."
- "Environment impact from new activity. Evidence of human health risk from fresh water."
- "Evidence of over exposure to BPA in bottled water."

Science and policy go hand in hand, as such, a disconnect among the two is a grave cause for concern. Scientific studies in 2008 (vom Saal, Akingbemi *et al.* 2007) demonstrated the potential harmful effects of BPA on human health at low doses. Subsequent to that, for the first time, some government agencies from the US acknowledged the concern of likely dangers of exposure to food and water containing BPA. This acknowledgment from the policy makers of BPA's potential harm propelled copious discussions of the chemical in only a few weeks, driving consumer demand for alternatives. Such a demand paved the way for and rekindled previous safer options such as oleoresins, polyester, polyamide, glass and polypropylene (Bailin *et al.*, 2008). Yet, responses from the Jamaican relevant stakeholders indicated a total unawareness of these global findings.

Even though the scientific findings at the time in the developed countries left some room for debate, the awareness of the potential harm of BPA from both the scientific and government communities propelled actions from consumers, manufacturers and retailers to err on the side of caution, in that, their knowledge of BPA paralleled actions taken to reduce exposure to the chemical. As scientific findings continue to unravel the concretized harmful effects of BPA, the actions taken by these communities paved the way for policy implementations that would contribute to safer human health on overall environment within these countries.

Table.1 BPA concentration in water at NWC treatment plants

NWC Facility	Sample	BPA Conc. (ng/L)
Ferry Treatment Plant	Post treatment	14.84
Hope Treatment Plant	Hope river inflow	18.28
	Reservoir	16.03
	post treatment	6.861
Constant Spring Treatment Plant	Constant Spring inflow	21.60
	Reservoir	4.691
	post treatment	8.132
Mona Treatment Plant	Hope river inflow	13.39
	Yallas river inflow	4.858
	Reservoir	5.129
	post treatment	8.691

BPA was extracted using Solid Phase Extraction (SPE) and eluted with a mixture of methanol and acetonitrile and analyzed using liquid chromatography tandem mass spectrometry (LC-MS/MS)

Table.2 A Wilcoxon Signed Ranks Test for BPA in water from NWC dams and inflows. **B** Wilcoxon Signed Ranks Test Statistics b for water from NWC dams and inflows

A

		N	**Mean Rank**	**Sum of Ranks**
BPA_TREATED *minus* BPA_RAW	Negative Ranks	2 [a]	2.50	5.00
	Positive Ranks	1[b]	1.00	1.00
	Ties	0 [c]		
	Total	3		

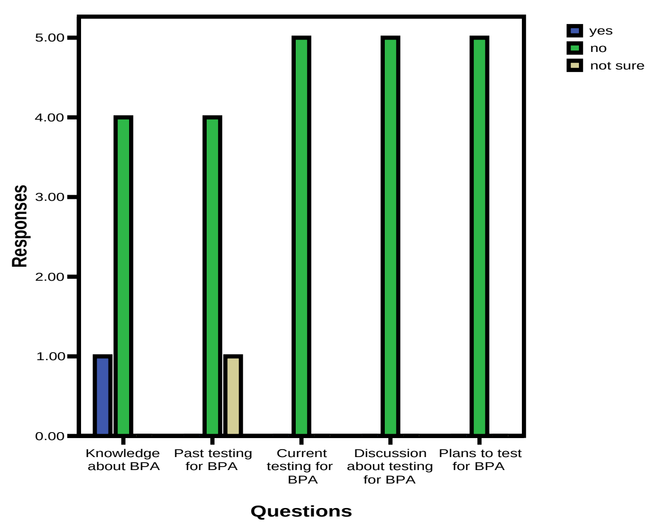
a. BPA_TREATED <BPA_RAW
b. BPA_TREATED > BPA_RAW
c. BPA_

B

a. Based on positive ranks
b. Wilcoxon Signed Ranks Test

	BPA_TREATED *Minus* BPA_RAW
Z	-1.069 [a]
Asymp. Sig. (2-tailed)	0.285

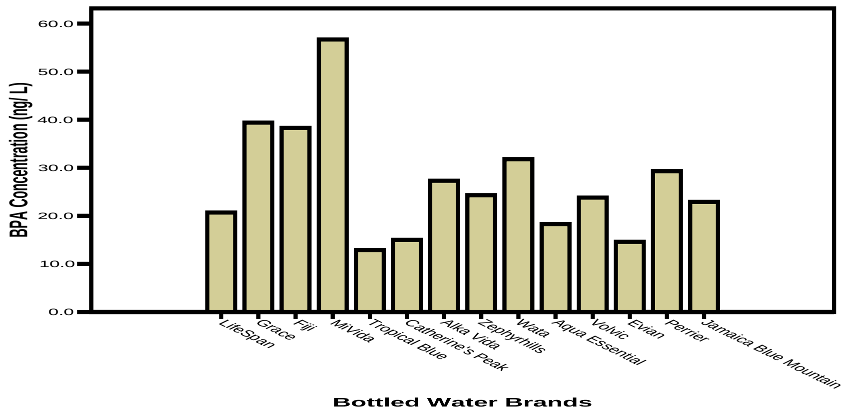
Figure.1 Responses from key stakeholders on the likelihood of testing for BPA



After receiving consent, a total of five persons based on their position and should be the most knowledgeable on the subject matter were interviewed from five key stakeholders, National Water Commission (NWC), National Environment and Planning Agency (NEPA), Ministry of Health (MOH) and Bureau of Standards Jamaica (BSJ).

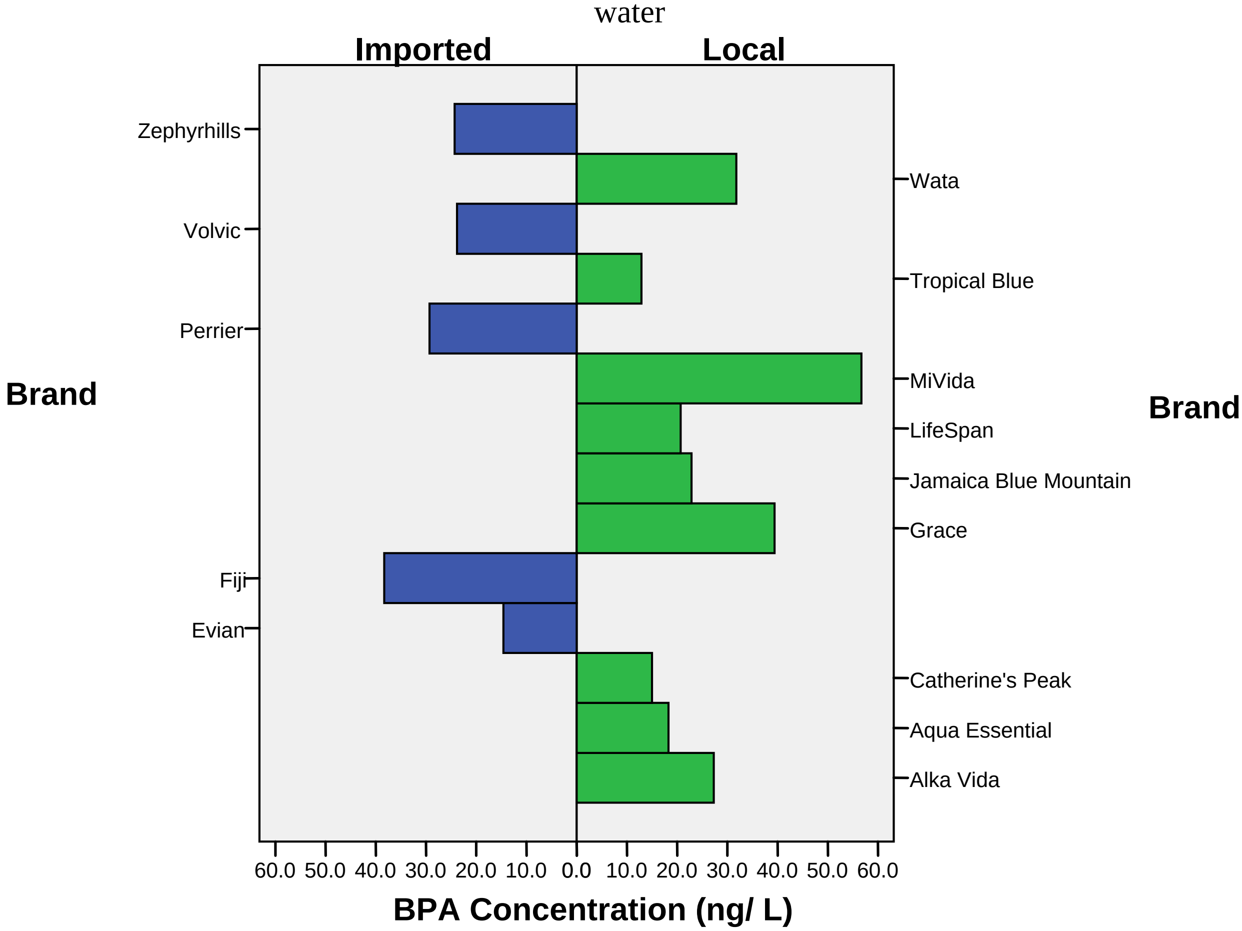
These institutions were selected because of their involvement in environmental and commodity monitoring and assessment in Jamaica.

Figure.2 BPA concentration in brands of bottled water



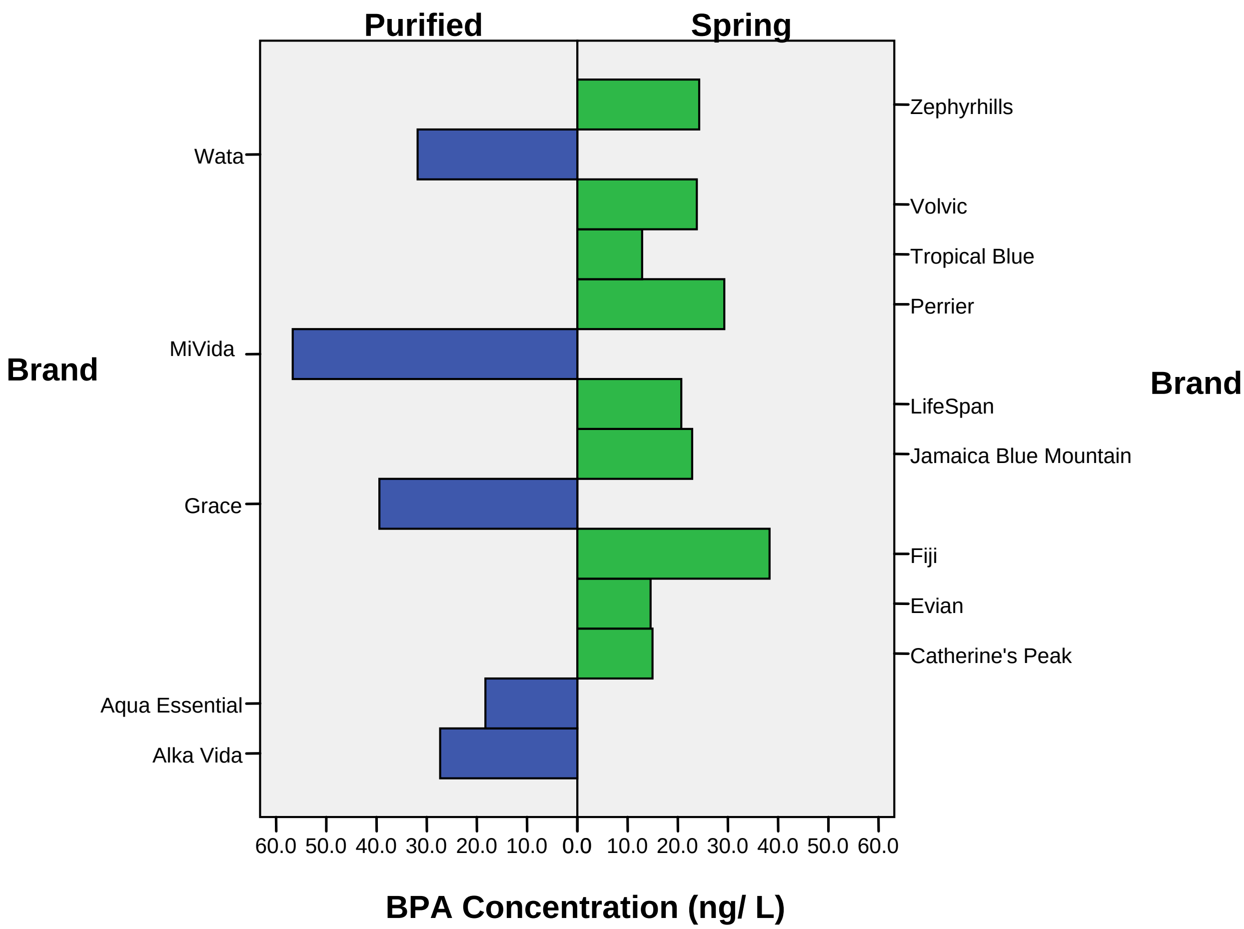
Of the 56 bottled waters registered for distribution in Jamaica, only 14 as listed above were found on the shelves of supermarkets in Kingston and St. Andrew. BPA was extracted using Solid Phase Extraction (SPE) and eluted with a mixture of methanol and acetonitrile and analyzed using liquid chromatography tandem mass spectrometry (LC-MS/MS).

Figure.3 BPA concentration in local and imported bottled water



BPA was extracted using Solid Phase Extraction (SPE) and eluted with a mixture of methanol and acetonitrile and analyzed using liquid chromatography tandem mass spectrometry (LC-MS/MS)

Figure.4 BPA concentration in spring and purified bottled water



BPA was extracted using Solid Phase Extraction (SPE) and eluted with a mixture of methanol and acetonitrile and analyzed using liquid chromatography tandem mass spectrometry (LC-MS/MS)

The release of the scientific report in 2008 in America indicating the *in vivo* effects of BPA coupled with the report released from the U.S. National Toxicology Program highlighting the cause of concern of BPA to human brain, prostate gland and behavior propelled the announcement of the Canadian regulatory body, Health Canada to ban the import, sale and advertising of polycarbonate baby bottles containing BPA (The Washington Post, 2008), Similar trends were evident in America (Sifferlin, 2012) and Europe (European Food Safety Authority 2007).

Currently, because of the awareness of the policy makers to BPA's effects through a strong scientific community, companies were forced to seek alternatives and some of these were previously mentioned though research is ongoing to ensure that these are indeed safer options.US retailers, Wal-Mart and Toys R Us announced in 2008 to phase out baby bottles containing BPA while Whole Foods Market had actioned this from as early as 2006 (Newsweek, 2008)'(Bailin *et al.*, 2008). Following the Canadian announcement to ban BPA containing baby bottles, manufacturers like Playtex and

Nalgene reacted by announcing a shift to BPA-free products while Gerber appears to be a leader in promoting BPA-free alternatives.

The major concern now is that while certain countries, mainly the developed ones are now making strides to not only educate their people about the effects of BPA but to lead a movement among the business communities to provide safer alternatives, underdeveloped countries are still lagging behind in awareness much less implementation. The findings from this research revealed the alarming statistics of a lack of BPA's awareness and testing among relevant stakeholders in Jamaica. Implications for this are major as majority of the general Jamaican populous are unlikely to be aware of BPA's effects. While local policy implementation is important, global policies of BPA's awareness and safety measures against the chemical is ongoing. Therefore, being aware of these and ensuring that Jamaicans are educated on the implications of BPA's exposure and measures they can take to minimize their BPA exposure is important. Some of these include: 1) how to store water and baby bottles, in that making sure that bottles are stored in cool temperatures since warmer temperatures favor increased levels of leached BPA; 2) reducing consumption of microwaved foods contained in polycarbonate and epoxy resin food containers; 3)being aware of the alternative BPA-free containers and using these instead. All these measures and more can be implemented from individual efforts while from a national effect, the government in addition to improving BPA's awareness, can implement certain bans on baby bottles that contain BPA and only allow BPA-free containers into the country only.

This project presents for the first time the lack of awareness of BPA and need for testing among relevant Jamaican stake holders despite its current global concern. Also, for the first time, the project reports BPA levels in treatment plants and bottled waters providing a preliminary indication of most suitable bottled water for consumption, the local brand. While the BPA levels from this one avenue is less that the acceptable exposure limit, established by EPA, it points to a need for a more comprehensive screening of BPA and its total assessment on the Jamaican populous. The findings from this research hopes to spur an interest among Jamaicans and other populous from underdeveloped countries with like traits who can from now be empowered and take steps to be fully informed of BPA and implement actions towards minimizing its intake. Also, it is hoped that there will be an immediate response from policy makers and stake holders re the implementation of steps in order to reduce the daily consumption of BPA among their people.

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