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RESEARCH ARTICLE

Spectra Analysis of Heavy Metals and Bisphenol - A Related Compounds in Sachet Water from Abia State Sub Metropolis

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Abstract

Three brands of sachet water were sampled within three loci within Abia state sub metropolis; the water samples were subject to analysis for heavy metals and bisphenol-A related compounds bioaccumulation using spectroscopy assay method. Control experiment was collected at approximately 1.04km from the suburb metropolis. Heavy metals of Fe and Cu were found in both the test and control experiments respectively, however, Fe and Cu were comparatively high (7.72 and 9.08 for sample I; 7.04 and 6.01 for sample II; 4.01 and 3.22 for sample III) in the test experiment than that of the control experiment. Heavy metals of Cd, Ni, As, Pb and Mn were below detectable limit in both experiments, respectively. FTIR spectroscopy showed the presence of an amide I bending in water from sample I while in sample II the amide I was well distorted however there are much hydroxylation around 3300cm^{-1} in all the three sampled sachet water. the present study is of clinical and environmental health significant as factory water processing is progressively increasing in our country due to demand from the population for elite supply. Information from this assessment will be a proper guide for monitoring agencies to tighten every exit points and maintain stringent policies for water processing companies.

Keywords: Sachet water; Heavy metals; Bisphenol-A; FTIR-spectroscopy

Introduction

Water is an essential necessity for every biological process (WHO, 2015). They are regarded as a universal solvent as all survival is largely dependent on it; markedly uncompromised water is characterized with properties designated with the basic chemistry of water (comprising its physical and chemical properties. Recently, there have been corresponding linear relationships between the increasing human consumption and the influx of pollutant into water supply ways (Shantanu et al., 2018). Human activities directly and indirectly towards search for quality water introduce eco unfriendly toxicants into the final processed water.

Among these toxicants are heavy metals and bisphenol A compounds. Heavy metals are metals with relatively high atomic mass and thus which reflect in their atomic weights; they take part in bio-geochemical reactions and are transported between compartments by natural processes, the rate of which are at times greatly altered by human activities (Ajiboye et al., 2011). They persist in nature and can cause damage or death in animals, humans, and plants even at very low concentrations (1 or 2 micrograms in some cases) (Ajiboye et al., 2011).

These metals enroute into plants, animals and human tissues through air inhalation, diet and manual handling [1]. Water sources (groundwater, lakes, streams and rivers) can be polluted by heavy metals leaching from industrial and consumer waste; acid rain can exacerbate this process by releasing heavy metals trapped in soils (Dueck, 2000). Invivo these health implicated metals competitively bind to cellular organelles such as structural proteins, enzymes, and genetic repertoires and interfere with their metabolic functioning [2]. Depending the nature and oxidative state of the concerned metal, symptoms and effects correspondingly varies and the dose involved. Broadly, long-term exposure to toxic heavy metals can have carcinogenic, central and peripheral nervous system and circulatory effects. For humans, typical presentations associated with exposure to any of the classical toxic heavy metals, or chromium (another toxic heavy metal) or arsenic (a metalloid) (Finch et al., 2015). Bisphenol-A are endocrine disruptors commonly associated with tumor activating proteins (oncogenes) [3]. They are activated under thermal treatment in polyethene bags and other alike containers (US EPA, 2006). Several studies have look into the aesthetic nature of package water distributed locally within our communities; their microbial quality, physical properties; however few have taken the research focus into estimation of heavy metal and bisphenol-A concentrations in sachet water distributed locally within Abia state sub metropolis. The study will clinically expose the impact of nylon packs on water samples produced by water factories within our communities; this assessment will form a guide to regulatory bodies whose duty is to quality assure the consumers the healthiness of their finished goods.

Material and Methods

Materials

All reagents, equipments used in the present study are from designated companies of reputability; the reagents are of analytical grade while the equipments are standardized at each use.

Methods

Water samples were gotten stratifiedly from three processing companies within Abia state suburb. Control experiment was gotten approximately 10 km from the initial sample sites. The sachet water were collected each in the morning while their temperature were maintained at 4°C using ice packs before analysis.

Water Digestion for Heavy Metal Analysis

The water samples before being subjected for heavy metal analysis was digested accordingly as described by [4]. Digestion was carried out using aqua raegia and aqua fortis in the ratio of 1:2 at 80°C for 2hrs.

Heavy Metals Analysis

Heavy metals analysis of the digested water samples was carried out using atomic absorption spectrophotometer machine. Standards of respective metals to be assayed for were prepared to respective concentrations while the analysis was carried out at each successive session of a particular analysed metal.

Spectroscopy Anaalysis of Bisphenol A Related Compounds

Fourier transform infrared (FTIR) spectra analysis of the sachet water were recorded at room temperature using 400 Perkin Elmer Agilent spectrometer (Perkin-Elmer, Norwalk, CA, USA). Spectrum was recorded from 4000 cm−1 to 500 cm−1 wavelength numbers. Sachet water was mixed with KBr at water/KBr ratio of 1:40. Spectra were obtained with a resolution of 4 cm−1 and were averaged over 32 scans.

Results

Table one, two and three below show the heavy metals estimated from the three sachet water localized within Abia state suburb. Heavy metals of As, Pb, Cd and Ni were not detected in the analysed sachet water. Fe and Cu were very much in abundance in the respective sachet water however, Mn were relatively low in concentration in the range of 0.011in only water from point 1 but recorded BDL in water from point 2 and 3 respectively.

Table 1: Heavy metal quantification in the table water from point one plant

Heavymetals Iron(Mg/ml)	Control 3.52	point 1 7.72
Cadmium(Mg/ml)	BDL	BDL
Nickel (Mg/ml)	BDL	BDL
Arsenic(Mg/ml)	BDL	BDL
Lead(Mg/ml) Manganese (Mg/ml)	BDL BDL	BDL 0.011
Copper(Mg/ml)	1.08	9.08

BDL=Below detectable limit; n=3

Table 2: Heavy metal quantification in the table water from point two plant

Heavymetals Iron(Mg/ml)	control 3.52	point 2 7.04
Cadmium(Mg/ml)	BDL	BDL
Nickel (Mg/ml)	BDL	BDL
Arsenic(Mg/ml)	BDL	BDL
Lead(Mg/ml) Manganese (Mg/ml)	BDL BDL	BDL BDL
Copper(Mg/ml)	1.08	6.01

BDL=Below detectable limit; n=3

Table 3: Heavy metal quantification in the table water from point three plant

Heavy metals control Iron(Mg/ml)	3.52	point 34.01
Cadmium(Mg/ml)	BDL	BDL
Nickel (Mg/ml)	BDL	BDL
Arsenic(Mg/ml)	BDL	BDL
Lead(Mg/ml) Manganese (Mg/ml)	BDL BDL	BDL BDL
Copper(Mg/ml)	1.08	3.22

BDL=Below detectable limit; n=3

Figure 1, 2 and 3 below show the Fourier transform infrared spectroscopy analysis of the sachet water for bisphenol A related compounds revealed characteristic absorption bands for the sachet water from respective points of the respective functionalities (O-H stretching), (CH-stretching), (Amide I), (Amide III), (–NH2 bending). The absorption bands at 1069.7 cm−1 45 (anti-symmetric stretching of the C-O-C bridge) and (skeletal vibrations involving the C-O stretching) are characteristic of its saccharide structure.

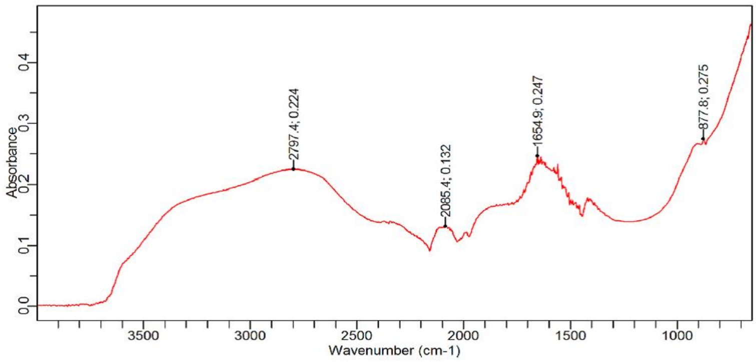

Figure 1: FTIR spectroscopy analysis of water sample from point 1

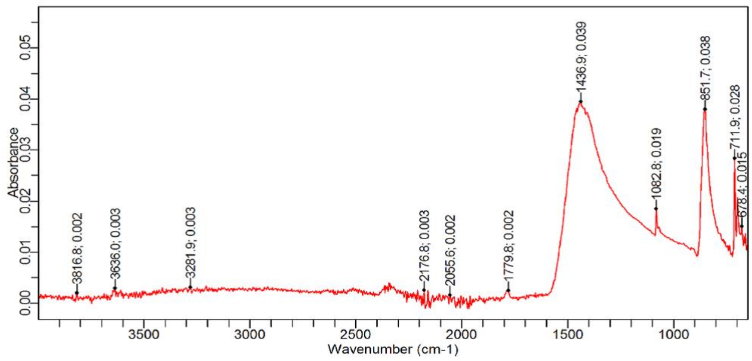

Figure 2: FTIR spectroscopy analysis of water sample from point 2

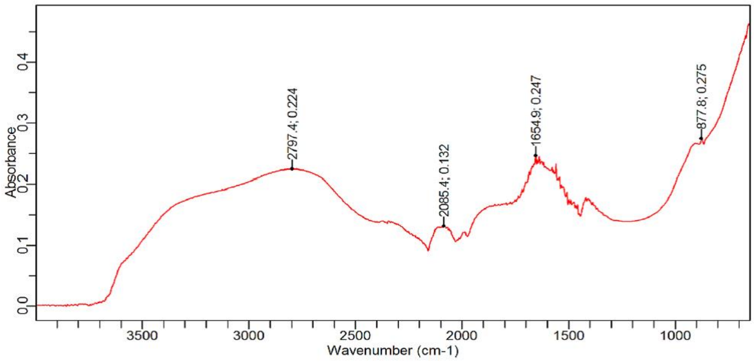

Figure 3: FTIR spectroscopy analysis of water sample from point 3

Discussion

Several on-going activities lead to introduction of contaminants to water; these contaminants are mostly inorganic ions which are introduced into the water from the source through which water flows and to a varying extent anthropogenic pollution by chemicals agents. Some of these contaminants are found in some of the packaged water produced in Abia state suburb because during the purification process the water is not thoroughly purified before being packaged by some of the industries.

In the present study, table water from table water factories within Abia state suburb were subjected to heavy metals and allied compounds determination. Table water from factory I showed the following: Fe 7.72 and 3.52 mg/ml for the test and control experiment respectively. Cu was found at 9.08 and 1.08 mg/ml for the test and control experiment respectively. Cd, Ni, As and Pb were below detectable limit in both treatments while Mn was found at 0.011 in the test experiment only. Table water from factory II showed the following: Fe 7.04 and 3.52 mg/ml for the test and control experiment respectively. Cu was found at 6.01 and 1.08 mg/ml for the test and control experiment respectively. Cd, Ni, As, Mn and Pb were below detectable limit in both treatments. Table water from factory III showed the following: Fe 4.01 and 3.52 mg/ml for the test and control experiment respectively. Cu were found at 3.22 and 1.08 mg/ml for the test and control experiment respectively. Cd, Ni, As, Mn and Pb were below detectable limit in both treatments. The result is in correlation with the findings of [5] who in a study on the physicochemical properties of table water within Enugu state showed the absence of heavy metals of Fe, Zn while tested Hg, Pb and As were below detectable limit.

Fourier transform infrared spectroscopy analysis of the table water for bisphenol A related compounds revealed characteristic absorption bands for table water from point I at 3244.6 cm−1- 3842.9 cm−1 (O-H stretching), 2165–2366.9 cm−1 (CH-stretching), 1654 cm−1 and 1718.3 cm−1 (Amide I), 1436.9 cm−1 (Amide III), 1407.1 cm−1 (–NH2 bending). The absorption bands at 1069.7 cm−1 45 (anti-symmetric stretching of the C-O-C bridge) and 902.1-687.7 cm−1 (skeletal vibrations involving the C-O stretching) are characteristic of its saccharide structure. FTIR analysis water from point II showed characteristic absorption bands at 3198.1 cm−1 (O-H stretching), 1996–2109.7 cm−1 (C-H-stretching), 1654 cm−1 (Amide I), 1459.3 cm−1 (–NH2 bending). The absorptivity showing anti-symmetric stretching of the C-O-C bridge and skeletal vibrations involving the C-O stretching of saccharide structure were destroyed by vibration.

FTIR analysis water from point III showed characteristic absorption bands at 2797.4 cm−1 (O-H stretching), 2085.4 cm−1 (C-H-stretching), 1654 cm−1 (Amide I), 1404.1 cm−1 (–NH2 bending). The absorption band only at 877.8 cm−1 (anti-symmetric stretching of the C-O-C bridge) and showed characteristic of its saccharide structure. Antonino et al. (2017) reported a characteristic absorption bands of at 3450 cm−1 (O-H stretching), 1870–2880 cm−1 (CH-stretching), 1655 cm−1 (Amide I), 1580 cm−1 (–N-H2 bending), and 1320 cm−1 (Amide III) for some rubber package water.

The absorption bands at 1160 cm−1 (anti-symmetric stretching of the C-O-C bridge), 1082 and 1032 cm−1 (skeletal vibrations involving the C-O stretching) are characteristic of its saccharide structure. [6] reported 46 the destruction of skeletal vibrations involving carbonyl bond stretching in Malaysian bottle water.

Conclusion

The study has shown the health risk implicative of sachet water sold locally within our metropolis. Concerned health recalcitrant of heavy metals and endocrine disruptors (bisphenol-A) are destructive agents of human and relative biosystems. Standard operational procedures (SOP) of many water producing factories need thorough quality assessment and overhauling by government regulatory bodies. In thereof, regulatory agencies are challenged to be up and factual to their activities in maintaining sanity and stringent policies towards production companies.

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Author's Contributions

Kenneth, Brendan: Conceived and designed the experiments, performed the experiment and processed the data, analyzed the data and wrote the manuscript.

Opete Onyinye: Revised the manuscript and performed the experiment.

Osunka, O: Performed the experiment and guided the experimental design.

Amadi, E.B.: Guided the experimental design and processed the data.

Onyenwuenyi, B.: Guided the experimental design.

Oparaji, Emeka H.: Processed the data and wrote the manuscript.

Ethics

Authors declared no ethical issues that may arise after the publication of this manuscript.

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