AN ASSESSMENT OF THE PHYSICOCHEMICAL QUALITY OF SOME BOTTLE WATER SOLD IN KANO METROPOLIS, NIGERIA

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ABSTRACT

Bottled water like any drinking water used for human consumption should be safe and of standard quality to ensure adequate public health significance. This study is aimed at assessing the physicochemical quality of some bottle water sold in Kano Metropolis. Studies on physicochemical parametric analysis were conducted. A total of 40 samples comprising of 4 different brands were randomly selected from different location. Physicochemical parameters of water samples such as Temperature, pH, Electrical conductivity, Total dissolved solids, turbidity, Magnesium, Calcium, Lead, Copper, Zinc, Bicarbonate, Chloride, Nitrate and Phosphate were analyzed using standard methods of water analysis. The Results of physicochemical parameters were within the drinking water regulatory standard. However, zinc, lead and copper was found to exceed the bottle drinking water standard in the ranges of 3.91 – 6.17Mg/l, 0.29 – 0.47Mg/l and 1.54 – 2.67Mg/l respectively; thereby rendering the water unfit to human consumption. There is the need to embark on routine monitoring and surveillances by the regulatory agencies involved to ensure effective implementation of WHO water safety plans from the catchment source to the consumer. This could be enhanced by replacing old pipes with new ones Bottled water industries should be designated away from heavy metal industries.

Keywords: Physicochemical, Bottled water quality, Kano metropolis

INTRODUCTION

The exponential trend of bottle water consumption over the last decades in Kano metropolis, Nigeria, cannot be over emphasized. However, more efforts are required to provide bottle water that meets the quality standards for human consumption. Safe drinking water as reported by WHO (2011) can save 1.8 million lives daily from incidence of water borne infection. Safe drinking water is an essential element for providing aesthetic and intellectual stimulation that lift the human spirit and improve health to human society Wegner et al. (2008). Thus, it is a powerful environmental determinant of health assurance as well as foundation for prevention and control of diseases as reported by (Kudesia and Ritu, 2003).

Literally bottled water can be defined as “any portable water that is treated of sanitary quality and intended for public consumption, bottled, distributed and offered for sale” (WHO, 2004 ; 2011). However, it can be simply referred to as water from some source (natural springs, wells, boreholes, municipal systems (Iliyasu et al., 2017) or other sources which are considered to be safe, of sanitary quality and fit for human consumption that a company has placed in plastic bottles, vessels, cans, laminated boxes; ranging from sizes of single serving to large carboys holding up to 80 liters resale for consumption (Magda et al., 2008).

It has been reported that, chemical qualities or composition of different type of bottled waters are largely influenced by geological and hydrological aspects of aquifers from which the water was drawn can result in the introduction of toxic and trace elements into the water in bottling process and treatment (Liee, 2011). It occurs in minute concentration in the order of 0.1mg/l in natural waters ; however, levels beyond tolerance limit can be a threat and hazard to public ( Kudesia and Ritu 2003). Moreover, some contaminants in form of heavy metals can interfere with the development of reproductive, endocrine, immune and nervous system many of which interfere or mimic both male and female hormone, thus modifying development and reproduction (Kudesia and Ritu, 2003; WHO, 2004)

The quality of bottle water can substantially vary among brands as well as with time, different production runs depending on its source, treatment technology, manufacturing operations, personal hygiene practices and shelf life before use (Ajayi et al.,2008;Liee,2011;Iliyasu et al.,2017).
It is against this background that, the paper is
aimed at collecting some samples of bottle
water sold within Kano metropolis, assessing its
physicochemical quality and comparing the
result with some national and international
standard through survey design and laboratory
experiment. This will be achieved with the
following objectives:

1. To collect some samples of bottle
water from different locations within
Kano Metropolis
2. To assess some of the physicochemical
qualities of the collected water samples
and compare the result with some
national and international standard.

Research Questions
1. How would the bottle water samples
collected?
2. What are the physicochemical qualities
and how would they be assessed?

MATERIALS AND METHODS
The research design involves survey design
through physical examination of the bottled
water samples (NAFDAC, 2004) and laboratory
experiment. Forty bottle water samples
comprising of ten each from four different
brands were collected fortnightly around the
metropolitan sample sites from retailed
outlets.

Sample collection and Physicochemical
Assessment of Water samples
Standard method of physicochemical analysis of
water was used to collect; processed and
analyzed the water samples using standard
methods within 6 hours of collection. (WHO,
2004 ; APHA, 2005). This include: Temperature
pH, Electrical conductivity, Total dissolved
solids, turbidity, Magnesium, Calcium, Lead,
Copper, Zinc, Bicarbonate, Chloride, Nitrate
and Phosphate.

Determination of Temperature
Temperature of water samples was determined
according to the method described by (Udo et
al.,2009; Njosi,2005). The temperature
measurement probe was inserted in the water
sample using probe number HI7662 of Hanna HI
255 model. The probe was allowed to stabilize
and the reading was recorded in °C according to
the manufacturers’ instruction.

Determination of pH
The pH of water samples was determined
according to the method described by (Udo et
al., 2009; Njosi, 2005) using pH meter probe
number HI 7662 (HI255) model. pH meter
was switched on and was allowed to stabilize; it
was then calibrated using buffer of 4 and 7 pH
to ensure accurate reading after which the
electrode of the meter was inserted into each
of the sample and was allowed to stabilize for
some seconds and the reading on the meter was
recorded.

Determination of Conductivity
Electrical conductivity was determined
according to the method described by (Udo et
al., 2009) The meter was calibrated using
standard potassium chloride solution after
which the probe of the conductivity meter was
suspended in air to Zero calibration. It was then
immersed into the sample by taping the probe
repeatedly to remove any trapped air bubble in
the sleeve. The probe was allowed to stabilize
and the reading on the meter was recorded
according to the manufacturer’s instruction in
µs/cm.

Determination of Total Dissolved Solids (TDS)
Total dissolved solid (TDS) was determined
according to the method described by (Udo et
al., 2009) with conductivity meter probe
number HI 76310 (Hanna HI255) model. The
meter was calibrated initially using standard
potassium chloride solution and then the
electrode of the meter was immersed in the
sample. It was allowed to stabilize and the
reading on the meter was recorded according
to the manufacturer’s instruction measured in
milligram per liter (mg/l).

Determination of turbidity
Turbidity of water sample was determined
according to the method described by Olajide
(2012) with digital turbidity meter HACH 2100N
Model. The meter was switched on and was
allowed to warm up for 10 minutes. 30ml of the
sample was dispensed and transferred into the
sample cell after which the turbidity of the
sample was recorded.

Determination of Nitrate
Nitrate concentration was determined
according to the method described by (Kudesia
and Ritu, 2003;Njosi,2005; Udo et al., 2009;
Olajide, 2012) using potable data logging
spectrophotometer (DR/2010 HACH).The
spectrophotometer was switched on and was
adjusted to a wave length of 500nm frequency.
One sachet of nitrate reagent powder was
transferred into a small bottle designed for the
nitrate analysis and 25ml of the water sample
was mixed with the reagent in the tube and
was placed in the spectrophotometer. The
meter was allowed to stabilize after which the
reading was taken and multiplied by 4.427
according to the manual instruction.

Determination of phosphate
Phosphate concentration was determined as
described by (Njosi, 2005; Udo et al., 2009;
Olajide, 2012) using potable data logging
Spectrophotometer (DR/2010 HACH) at a
frequency wave length value of 890nm.
Twenty five milliliter (25ml) capacity bottle was filled up with the water sample and was mixed with the reagent powder and placed in the spectrophotometer according to the manual instruction and the reading was taken.

**Determination of Lead, Calcium, Magnesium, and Copper and Zinc**

Lead, calcium, magnesium, copper and zinc were determined according to the method of (AOAC, 1984; Kudesia and Ritu, 2003; APHA, 2005; Njosi, 2005; Udo et al., 2009). 125ml of the water sample was distilled in a beaker and was digested by putting on a hot plate and evaporated at a temperature of 350 ° C to a concentration of 25ml. The filter of the digest was allowed to cool. The digest was diluted up to 100ml volume with distilled water and was aspirated into an air acetylene flame of the Atomic Absorption Spectrophotometer Model 210VGP (AAS). The absorbance at auto zero set was read after the ready key display at an absorbance of 279.5nm for each sample. For example Zinc absorbance was read at a current of 2.0 ohms lamp.

**Determination of chloride**

Chloride of water sample was determined according to the argentometric method described by (AOAC,1984; Njosi, 2005) 5ml to 20ml of the water sample was transferred into a conical flask and 2 to 3 drops of potassium chromate was added to obtain yellowish coloration. It was titrated with 0.1 molar silver nitrate solutions until the pink color end point was attained after which the record of the concentration of the chloride used was noted and recorded and the result was calculated.

**Determination of Bicarbonate**

Bicarbonate was determined according to the titrimetric method described by (AOAC, 1984; Njosi, 2005; Udo et al., 2009). 10ml of sample was introduced into a conical flask and 2 to 3 drops of phenolphthalein indicator was added. A color change in the water sample to a pink coloration indicated the presence of carbonate. The estimate of amount of carbonate was carried out by titration with 0.1M sulphuric acid to colorless neutralization point and the end point was noted and recorded. 2 drops of methyl orange indicator was added and titrated with same 0.1M acid, until a color change from orange to pink was obtained, and the final reading was recorded.

**RESULTS AND DISCUSSION**

The values of pH ranged between; 6.6-7.0 which are within the recommended value by WHO/NAFDAC. The temperatures of all the four brands exceeded the aesthetic standard of palatability of 15°C. Brand C had the highest electrical conductivity of 93.29µS/cm and TDS of 43.81mg/l while brand A had the least electrical conductivity of 17.00µS/cm with a TDS value of 7.96mg/l.

The values of all the brands were within the 1000µS/cm standards recommended by WHO/NAFDAC. Brand C had the highest turbidity value of 0.55 NTU while the lowest turbidity of 0.14 NTU was recorded in brand D which showed a significance difference. However the result was within the standard limit by WHO/NAFDAC of 1 NTU. Brand D had the highest value of 105.9mg/l of magnesium while brand C had the least value of 66.15mg/l and were within the recommended standards of 30-150mg/l. Brand C had the highest value of 175.98mg/l of calcium, while brand A had the lowest value of 124.40mg/l and were within the recommended standard of 75-200mg/l. The highest chloride value of 28.4mg/l was recorded in sample B while the lowest value was recorded in brand D, all the brands met the recommended chloride concentration value of 250mg/l. Brand A had the highest bicarbonate value of 46.514 mg/l while brand d had the lowest value of 19.82mg/l. Brand A had the highest nitrate value of 0.868mg/l while the least value of 0.67mg/l was recorded in brand B and was within the regulatory standard limit of 50mg/liter. The highest value of 0.307mg/l of phosphate was recorded in brand A while brand B had the least value of 0.254mg/l; the concentration of phosphate was within the regulatory standard limit of 5mg/l.

The mean concentration of lead was found to be higher in all the brands than the zero (0) WHO/NAFDAC standard which by implication is toxic to consumers. The toxicity effect of lead poison symptoms over long term exposure according to (Nriagu,1988; Kudesia and Ritu,2003;Olajide,2012) include; mild anaemia through heamoglobin synthesis disruptions, brain damage, vomiting, loss of appetite, convulsion, uncoordinated body movements, metallic tastes, changes in bone marrow, trouble in urine system, blue line, dysfunctions of the gastrointestinal tract and headache. Onimawo, (2013) attributed crime and antisocial behaviors in children to high levels of lead beyond concentration in drinking water source. Olajide (2012) reported that, sources of Lead in drinking water may be from water pipes and faucet, paint pigments, car and generator exhausts from chemical industries, insecticides and ceramic glazes. Studies have demonstrated that, toxicity of lead as a result of underground water contamination as through land fill of Polyvinyl chloride (PVC) pipes leaches lead organic compounds additive materials of barium/zinc and cadmium/zinc used as
stabilizers in PVC USEPA (1986) as well as high cost and time of replacing old solder pipe line with new ones might be the route of exposure to higher concentrations. The findings was in line with the findings of Al-Saleh (1996) in Riyadh Saudi Arabia also recorded higher level of lead in bottled water and Dabaka (2002) in Canada also recorded high level of lead because of standing time.

Copper was also found to be above the drinking water standards of 1.0 as compared to WHO/NAFDAC. Copper contaminants can get into water bodies over a long distance of 8km as fertilizers, fungicides as well as algaeicides as reported by Olajide (2012). Copper occurs in drinking water as native metal and in sulphur ores in nature and often increase during distribution, especially in systems with acidic p\(^{2}\) or higher carbonates waters with alkaline p\(^{2}\). Longer time exposure to concentrations above standard for example at concentration Cu (470mg) in the body is toxic and is characterized by symptoms of hypertension, kidney and liver damage sporadic fever, uremia, pathological changes in brain tissue, coma and finally death(Kudesia and Ritu,2003).The result of the researcher was in line with studies conducted by Al-Saleh (1996) in Riyadh Saudi Arabia also recorded exceeded WHO limit of Zinc, Saleh et al. (2001) in Egypt, Ikem et al. (2002) in Alabama also recorded high Zinc level above USEPA & EU standard for drinking water. Muhammad et al. (2010) in India recorded a exceeded WHO limit in a similar study as it was recorded from the findings.

CONCLUSION

In conclusion, physicochemical qualities of the bottle water such as Temperature, pH, Electrical conductivity, Total dissolved solids, Turbidity , Magnesium, Calcium, Bicarbonate, Chloride, Nitrates and Phosphate were within the drinking water standard. However, lead, zinc and copper were found to exceed the WHO/NAFDAC standard and might render the bottled water unfit for human consumption as it can lead to health hazards over long exposure.

Table 1: Mean Variations of Physicochemical Parameters of Bottled Drinking Water Samples

| Parameters          | Unit   | A      | B      | C      | D       | WHO/NAFDAC | USEPA/USFDA | S.E |
|---------------------|--------|--------|--------|--------|---------|------------|-------------|-----|
| Temperature         | °C     | 29.26  | 29.52  | 29.18  | 29.70   | 15         | N/A         | 0.233 |
| p\(^{2}\)           | Scale unit | 6.7\(^a\)  | 6.9\(^a\)  | 7.0\(^a\)  | 6.6\(^a\)  | 6.5-8.5   | 6.5-8.5     | 0.172 |
| Electrical conductivity | µS/cm | 17.00\(^b\) | 70.12\(^a\) | 93.29\(^b\) | 33.0\(^b\) | 1000       | -           | 8.171 |
| Total dissolved solids | Mg/l  | 7.96\(^a\) | 32.93\(^a\) | 43.81\(^a\) | 15.50\(^b\) | 500        | 500     | 3.838 |
| Turbidity           | NTU    | 0.27\(^a\) | 0.26\(^b\) | 0.55\(^a\) | 0.14\(^b\) | 1-<5       | N/A         | 0.048 |
| Magnesium           | Mg/l   | 86.07\(^a\) | 69.19\(^a\) | 66.15\(^a\) | 105.91\(^a\) | 30-150     | -           | 14.190 |
| Calcium             | Mg/l   | 124.40\(^b\) | 141.54\(^a\) | 175.98\(^a\) | 144.12\(^a\) | 75-200     | -           | 18.146 |
| Lead                | Mg/l   | 0.29\(^a\) | 0.450\(^a\) | 0.427\(^a\) | 0.472\(^a\) | 0.01       | 0           | 0.037 |
| Copper              | Mg/l   | 1.553\(^a\) | 2.524\(^a\) | 2.679\(^a\) | 1.548\(^a\) | 1.0        | 1.0         | 0.181 |
| Zinc                | Mg/l   | 3.911\(^a\) | 5.689\(^a\) | 3.911\(^a\) | 6.177\(^b\) | 3.0        | 5.0         | 0.470 |
| Bicarbonate         | Mg/l   | 46.514\(^a\) | 41.419\(^a\) | 21.354\(^b\) | 19.824\(^b\) | -          | -           | 4.700 |
| Chloride            | Mg/l   | 24.847\(^b\) | 28.400\(^b\) | 26.625\(^b\) | 17.750\(^a\) | 250        | 250         | 3.272 |
| Nitrate             | Mg/l   | 0.868\(^b\) | 0.679\(^b\) | 0.785\(^b\) | 0.808\(^b\) | 50         | 10          | 0.046 |
| Phosphate           | Mg/l   | 0.307\(^b\) | 0.254\(^b\) | 0.663\(^b\) | 0.796\(^b\) | 5.0        | -           | 0.026 |

Student- Newmann-Keuls Test α = 0.05; Means values with the same letter are not significantly different

Key: mg/l=milligram per liter; NTU=Naphlometric Turbidity unit; N/A = not available; S.E standard error
RECOMMENDATIONS
The following recommendations are made from the findings

1. There is the need to embarked routine monitoring and surveillances by the regulatory agencies involved to ensure effective implementation of WHO water safety plans from the catchment source to the consumer.

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