AN ASSESSMENT OF THE MICROBIOLOGICAL 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. The aim of the study is to assess the quality of some bottle water sold in Kano Metropolis and compare the result with some national and international standards. Studies on the microbiological parametric standards, was conducted. A total of 40 samples comprising of 4 different brands were randomly selected using stratified sampling techniques from different sites of Kano metropolis in northern Nigeria. Samples were analyzed for the presence of bacterial indicators of water quality using pour plate and MPN techniques. The result of Total aerobic Plate counts (APC) ranged from 2.06x10^2 -3.8x10^2 cfu/ml of the entire brand. All the bottled water brands had a mean (APC) greater than 100cfu/ml of bottled water standard. Total coliform and Eschericia coli were detected in two brands and were above the zero cfu per 100milliter of bottled water standard. No pathogenic bacteria were isolated except for Staphylococcus. Effective implementation of WHO water safety plans from the catchment source to the consumer through campaign awareness can reduce level of exposure to stakeholders to protect and store bottle water against sunlight exposure, chemicals and cleaning reagents.

Key words: Quality, Bottled water, Kano Metropolis

INTROODUCTION
The safety perceptional rising trend of bottle water consumption over the last decades in Kano metropolis, Nigeria, cannot be over emphasized only when all hands are put on deck to provide bottle water of safe quality standards for human consumption. Safe drinking water as observed by Kudesia and Ritu (2003) and Wegner et al. (2008) as an essential element for providing aesthetic and intellectual stimulation that lift the human spirit and improve health to human society; there by saving 1.8 million lives daily from incidence of water borne infections WHO(2011).

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) 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).

Globally, in the wake of several major outbreaks involving food and water, there is a growing concern for the safety and quality of drinking-water. While bottled water is widely available in both industrialized and developing countries, empirical studies have shown that, the qualities of some bottled waters sold are not fit for human consumption. Sasikaran et al. (2008)

Waterborne diseases remain a major hazard in many parts of the world and are contacted by drinking water that contains pathogenic organisms, usually due to faecal contaminations. Consumption of water contaminated by disease causing agents of pathogens, toxic chemicals as reported by Wegner et al. (2008) can cause health problems such as diarrhea, cholera, typhoid fever, dysentery, skin diseases and cancer.

Water quality as a concept means water that has a pleasing taste and appearance obtained from a self- purifying source, not polluted with contaminants and safe to drink (Barbara and Hudson, 1997). The quality of water is most frequently used by reference to set of standards against which compliance can be assessed.
The quality of bottle water can substantially vary among brands as well as with time, with different production runs depending on its source, treatment technology, manufacturing operations, personal hygiene practices and shelf life before use. (Magda et al., 2008; Liee, 2011). It is against this background that, the paper is aimed at analyzing samples of bottle water sold within Kano metropolis, assessing its microbiological quality and comparing the result with some national and international standard through survey design and laboratory experiment.

MATERILALS AND METHODS
A total of 40 bottle waters from 4 different brands were collected fortnightly for six months. All the samples collected were processed and analyzed using standard methods within 6hours of collection (WHO, 2004; APHA, 2005).

Microbiological Assessment of Water Sample
Standard method of microbiological analysis of water was used to enumerate, isolate and characterize some microorganisms of public health significance. Aerobic mesophilic bacterial count (APC) was determined by pour plate method and cultured at 37°C for 24-72 hours as described by Kudesia and Ritu (2003) and APHA (2005). Microorganisms’ identification and Coliform enumeration was assessed as described by Atlas (1997) Barbara and Hudson (1997) Burton and Michael (1999). Detection and isolation of Pathogenic bacteria was determined according to the method described by (WHO, 2004; APHA, 2005).

RESULTS
Bacterial Load and Identified Microorganisms
The result of bacterial load as shown in (Table 1) below indicated that, Brand A had the highest aerobic mesophilic count of 3.8x10^2 cfu/ml while brand B had the least aerobic mesophilic count of 2.06x10^2 cfu/ml; however, the aerobic mesophilic count for all the brands of bottled water were higher than the WHO (2011) and NAFDAC (2004) of 100 CFU/ml of bottled drinking water standards. On the other hand, coliform count of sample brand A and C were found to be higher in the range of <1.8-9.3) while sample B and D were found to be within the limit <1.8 respectively. So also, 5% of the total samples exceed the 0 cfu/100 ml of excellent treated bottled water. E. coli and Staphylococcus spp. was identified in brand A while Klebsiella spp. and Staphylococcus spp. were detected in brand C.

<table>
<thead>
<tr>
<th>BRAND</th>
<th>APC (Cfu/ml)</th>
<th>CC (MPN/100ml)</th>
<th>E. coli</th>
<th>Salmonella</th>
<th>Shigella</th>
<th>Staphylococcus</th>
<th>Enterobacter</th>
<th>Klebsiella</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.8X10^2</td>
<td>&lt;1.8-9.3</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>B</td>
<td>2.06X10^2</td>
<td>&lt;1.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C</td>
<td>3.25X10^2</td>
<td>&lt;1.8-6.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>D</td>
<td>2.55X10^2</td>
<td>&lt;1.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

WHO/NAFDAC Standard: 1.0x10^2 (100 CFU/ml) (zero)

KEY: CC: Coliform Count; MPN: Most Probable Number; APC: Aerobic Plate Count

Mean Microbiological Parameters of Bottled Water Sample
The result of the mean microbiological parameters of bottled water (Table 2) showed that, no coliform of feacal origin was isolated at the time of the study. All brands exhibit insignificant load of Staphylococcus spp. in the range of 0.4x10^1 cfu/ml - 1.0x10^1 cfu/ml.

<table>
<thead>
<tr>
<th>Sample Brand</th>
<th>APC (Cfu/ml)</th>
<th>CC (MPN/100ml)</th>
<th>Feacal coliform</th>
<th>Salmonella</th>
<th>Shigella</th>
<th>Staphylococcus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brand A</td>
<td>3.8X10^2</td>
<td>&lt;1.8-9.3</td>
<td>Nil</td>
<td>0</td>
<td>0</td>
<td>1.0X10^1</td>
</tr>
<tr>
<td>Brand B</td>
<td>2.06X10^2</td>
<td>&lt;1.8</td>
<td>Nil</td>
<td>0</td>
<td>0</td>
<td>0.8X10^1</td>
</tr>
<tr>
<td>Brand C</td>
<td>3.25X10^2</td>
<td>&lt;1.8-6.8</td>
<td>Nil</td>
<td>0</td>
<td>0</td>
<td>0.4X10^1</td>
</tr>
<tr>
<td>Brand D</td>
<td>2.55X10^2</td>
<td>&lt;1.8</td>
<td>Nil</td>
<td>0</td>
<td>0</td>
<td>0.4X10^1</td>
</tr>
<tr>
<td>WHO/NAFDAC</td>
<td>1.0X10^1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Key:
APC = Aerobic Mesophilic count
CC = Coliform count; MPN= Most Probable Number
n/a = Not available
DISCUSSION
The aerobic mesophilic count in all the sampled brands exceeded the 100 colony forming unit of bottled water standard of WHO/NAFDAC (2004). High aerobic mesophilic bacterial count might be as a result the normal flora of the water source as well as inadequate bottled water treatment for example, failure of ozonation or ultraviolet radiation (UV) of equipment and water disinfection method and poor hygienic condition of the water handlers along the channels of distribution. Poor storage of water at longer duration of elevated temperature by retailers can also increase the re-growth of the microorganisms. Bottled water may be in distribution at elevated temperature and poor storage condition for several weeks which may adversely affects its quality. Similar studies conducted by Magda et al. (2008) in Egypt, Liee (2011) in South Africa, Oyedeji (2012) in Ile Ife, Nigeria, Sasikaran et al. (2012) in Sri Lanka as well as Timilshina et al. (2012) in Kathmandu, all recorded high Aerobic Mesophilic Count range that exceeded the 100cfu/ml standard of bottled drinking water as recorded by the researcher. Coliform count of 5% from brand A and C above the zero permissible limits was found to be unfit for human consumption as it exceeds the 0 cfu/100ml of excellent treated bottled water. Contamination might be as result of normal flora as well as poor storage on the parts of the water handlers due to stock rotation along the channels of distribution, colonization by microorganisms of bottling plant equipment’s as rubber seals, lining or coating, washers and even disinfection soaps may provide nutrients for these organisms. Liee (2011). Moreover, a parallel analysis carried out in the National reference laboratory in 2014 using membrane filtration technique revealed a coliform count of 56cfu/ml. The presence of indicator organisms is an indication of recent fecal pollution which renders the water unfit for human consumption. Presence of Staphylococcus spp. in water samples was so insignificant to cause disease as there was no evidence of transmission through the consumption of such water (LeChevallier and Seidler, 1980). Similar studies conducted by Magda et al. (2008) in Egypt recorded total coliform above standard. The result of Liee (2011) in South Africa differs from that of the researcher in terms of total coliform but was in line with the result of this work as no coliform of feacal origin was detected in all the sample brands. Oyedeji, (2012) in Ille-Ife, Nigeria detected total coliform and E. coli in only one brand and this was in line with the result of this work. Sasikaran et al. (2012) in Sri Lanka found that 14 (9%) out of the 22 bottle water brands were unfit for human consumption as they contain fecal count of either E. coli or Staphylococcus exceed the WHO standards. Timilshina et al. (2012) Kathmandu valley, recorded ranges above the WHO 100cfu/ml standard in bottled drinking water.

CONCLUSION AND RECOMMENDATIONS
In conclusion, high aerobic mesophilic bacterial and coliform counts which were found to be above standard might render the bottled water unfit for human consumption. It is recommended that research should be conducted on the raw water source as the number of bottled water companies are on the increase.

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