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Assessment of the Microbial Quality of Sachet Water in Damaturu-Yobe State, Nigeria

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Abstract

The microbial qualities of eighteen 500ml sachet water samples vended for drinking in Damaturu, Yobe State, Nigeria were investigated using standard analytical tests. The results of the microbial examination indicate that only 55.56% of the samples showed coliform count ranging from 0-1 per 100ml of the samples. Results also showed that 44.44% of the 500ml sachets were contaminated by *Bacillus species*, 16.66% by *Escherichia coli* and 11.11% by *Staphylococcus aureus*. This indicates that only about 27.78% of the samples fell within the National Agency for Food and Drug Administration and Control (NAFDAC) acceptable limits and are therefore safe while 72.22% are unsafe for drinking. There is therefore the need to enforce the NAFDAC drinking water regulatory guidelines and frequent monitoring should be ensured to safeguard human lives in the area of study.

Key words: Acceptable Limit, Microbial Quality, Regulatory Guidelines, Sachet Water

Introduction

Clean water is essential for human consumption more than any environmental factor. However, in Nigeria, though much has been achieved after 52 years of independence but the quality and quantity of safe drinking water is still grossly inadequate in some areas. This inadequacy compelled people to purchase and use water from hawkers who obtain the water from polluted environment and it is a well known fact that the intake of unclean water could cause devastating microbial diseases with serious effects on human health (Steiner *et al.*, 1997).

Yobe State like quite a number of states in Nigeria is faced with increasing pressure on water resources though provision of potable water is always considered to be a priority in the state's yearly budget. The widespread and long lasting water shortages in many areas are as a result of rising demand, unequal distribution of usable fresh water and increasing pollution of existing water supplies.

Prior to the introduction of sachet water in Nigeria and Yobe State in particular, the local people use alums and termarind to purify their

water since they cannot afford water filters. The drinking water technology used in the developed world cannot be afforded by individuals (Gadgil and Derby, 2003). However, when sachet water was introduced in Damaturu around 1999, the people welcomed and accepted it because it is handy, ready to drink, affordable and assumed to be 'pure' and they abandoned their local purification techniques. Many researchers (Adekunle *et al.*, 2004; Dada, 2009) have questioned the quality of sachet waters and the unhygienic environments where they are produced and non adherence to NAFDAC guidelines (NAFDAC, 2004).

The investigation of the microbial quality of the sachet water is designed to assess the total coliform content which has been used as the primary indicator bacteria for the presence of disease causing organisms (PHLS, 2000; APHA, 1992; PHLS/SCA, 1981). In order to associate the risk of microbial contaminants in the water to human health, the pathogens which perpetuate many diseases will also be examined. Examples of these dangerous pathogens include *Escherichia coli*,

Staphylococcus aureus, *Bacillus species*, *Salmonella typhi*, *Pseudomonas aeruginosa* and *Corynebacterium species* (Ashbolt *et al.*, 1993). The objective of this study is to determine the coliform counts and isolate the pathogens present in the samples in order to assess the microbial qualities of both NAFDAC approved and yet to be approved samples. The result is also expected to provide information on the safety and risk of drinking sachet waters containing microbial contaminants.

Materials and Methods

Study Location

Damaturu is the Yobe State capital which is located in the North Eastern Nigeria with the following geographical coordinates; 11° 44' 55" North and 11° 57' 50" East (Google Earth, 2011). The state capital has a total area of 2,366km², and an estimated population of 44268 based on the 2006 Nigerian Census figures (NPC, 2006).

Sampling

Eighteen different brands of 500ml sachet water samples were purchased from different vendors in Damaturu, Yobe State capital. The samples were coded and includes AW, BW₁, BW₂, BW₃, DW, GU, GW, HW, KW, LW, MK, MS, RS, RW, SW, YW, ZW₁ and ZW₂. Duplicate samples were collected per brand and analyzed within 24 hours of collection.

Microbial Analyses

Presumptive and confirmatory coliform counts were conducted using the most probable number method (APHA, 1998). The various pathogenic organisms were isolated using Blood agar, Mc Conkey agar, Mannitol salt agar, tellurite blood agar and Kligler iron agar. The isolates were identified based on standard techniques (Warburton, 2000; SSLWC, 1982).

Results and Discussion

The results of the presumptive and confirmatory coliform counts are shown in Figure 1. The presumptive test showed that ten samples contained 0-1 coliform per 100ml while nine samples contained 2-8 coliform per 100ml of the sample indicating pollution. The confirmatory coliform count results indicate that only six samples were free of coliform,

seven of the samples contained 1-2 and five samples contained >2 coliform per 100 ml of sample (PHLS, 2000). The fact that presence of coliform organisms are indicative of other pathogens and hence contamination of the water indicate only six of the samples investigated are safe for drinking as stipulated by NAFDAC that coliform must not be detected in any 100ml sample (NAFDAC, 2001; WHO 2006). The tested water samples were graded based on WHO grading (WHO, 1971) and the results shows that six samples were found to be excellent; four were satisfactory while eight were intermediately polluted. Similar contamination of sachet water by coliforms have been reported in similar studies (Onifade and Ilori, 2008; Dada, 2009; Adewoye *et al.*, 2011) and were associated to poor handling of the products by the producers and vendors.

E. coli were isolated in three of the samples (BW₁, MS, ZW₁); *Staphylococcus aureus* were isolated in two samples (KW, SW) while eight samples (BW₁, BW₂, KW, MS, RW, SW, ZW₁, ZW₂) contained *Bacillus species*. However, *Salmonella typhi*, *Pseudomonas aeruginosa* and *Corynebacterium species* were not detected in any of the tested samples. The percentage frequencies of occurrence of the isolated bacteria are shown in Figure 2. The figure shows the following decrease in order of occurrence; *Bacillus species* > *E. coli* > *Staphylococcus aureus*. Regardless of the nature and degree of occurrence, exposure to any of the isolated bacteria has health effects ranging from mild to moderate cases and may result in death especially for those with weak immune systems. The potential health effects of *E. coli* include urinary tract infections, appendicitis, meningitis in new born and diarrhea in infants while *Bacillus species* causes meningitis, endocarditis and eye infections. *Staphylococcus aureus* causes abscesses, ulcers, inflammation of the breast and conjunctivitis in new born (Cheesebrough, 2000; Kassenger, 2007). The presence of coliform organisms and isolation of pathogens especially *E. coli* is indicative of fecal contamination and likely presence of other enteric pathogens (Petridis *et al.*, 2002; Cheesebrough, 2000; Chao *et al.*, 2004), therefore all samples which contained them are considered to be unsafe for human consumption.

The possible causes of these microbial contaminants found in this study include long time exposure and poor handling of the products by the producers and vendors. Series of visits to over 80% of the manufacturing factories also revealed that cheap labor with poor personal hygiene were employed to handle processing of products. This unhygienic handling of the products could cause health problems to the consumers as over 90% of consumers tear the sachet with their teeth to drink the water. Other possible causes of contamination are; poor purification procedures and resistance of the pathogens to disinfectants and other water treatment agents. The sources of the water used for the production of the sachet water may also be a contributory factor.

Conclusion

The presence of coliform and the isolated pathogens in some of the samples confirm the risk involved in consumption of such products and are therefore hazardous to human health.

One of the functions of NAFDAC is to ensure quality assurance, ensure that regulations and guidelines for the production, sale and distribution of bottled or sachet water were adhered to. However, it is sad to note that in the area of study, some of the products do not have NAFDAC numbers and none of the products have manufacturing nor expiration dates which are very vital and can provide a kind of ‘on the spot’ guide to the buyer and consumers of the products. There is therefore need for continues monitoring of the quality of the water and the environment they are produced by NAFDAC and all unregistered products must register before marketing. Considering the high patronage of sachet water in the area of study, it is also recommended that all manufacturing industries must adhere to NAFDAC guidelines and all the existing laws should be enforced. Furthermore, extensive surveillance of the industries and if possible more stringent regulations should be developed and enforced to safeguard the health of the people.

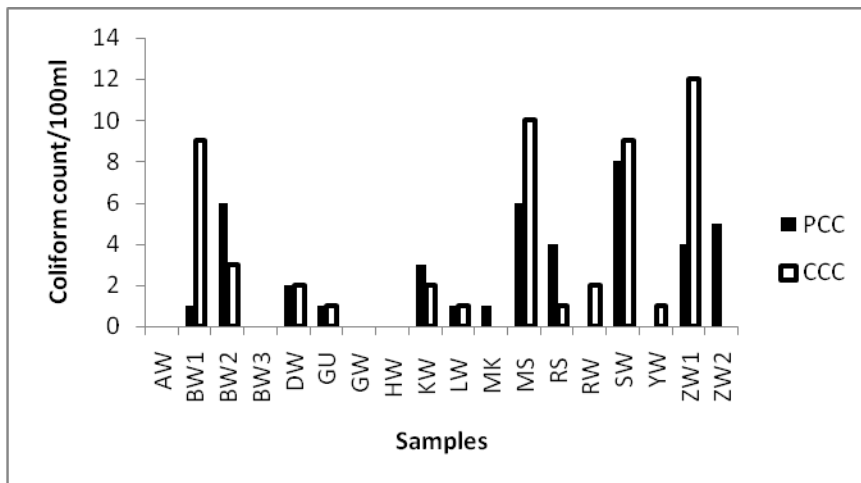


Figure-1 Presumptive (PCC) and Confirmatory Coliform Counts (CCC) for the tested water samples

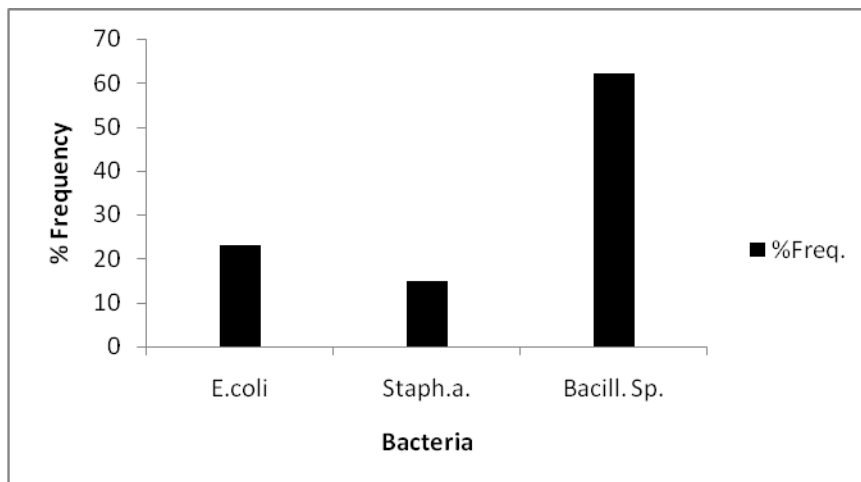


Figure-2 Frequency of isolation of bacteria in the tested water samples

E.coli- *Escherichia coli*

Staph. a- *Staphylococcus aureus*.

Bacill. sp- *Bacillus species*

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