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Bacteriological profile of drinking water packaged in plastic bags sold to travellers stranded at Malanville border crossing in northern Bénin (West Africa)

Doscoph Cyr Afle[1], Daton Sylvain Kougblenou[2], Fadéby Modeste Gouissi[*3]

[1]*National Agency For Quality Control of Health Products and Water, Ministry of Health, 06 PO Box 139 Akpakpa Donantin, Bénin*

[2]*National Public Health Laboratory, Section of Hygiene, Water and Food, Ministry of Health, 01 PO BOX 418 Akpakpa Donantin, Bénin*

[3]*University of Parakou (UP), Faculty of Agronomy (FA), Laboratory of Ecology, Health and Animal Production (LESPA), BP 123 Parakou, Bénin*

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Abstract

Bacterial identification in drinking water packaged in plastic bags is important for human health. The presence of faecal pollution is a factor in assessing the quality of water. Samples of drinking water packaged in plastic bags were randomly collected from water traders at the site of stranded travellers at the Malanville border crossing in northern Benin (West Africa). 88 samples were taken and analysed in Laboratory of Food Microbiology, Ministry of Health (Bénin). All statistical analyses were performed using SPSS Statistics 21 software. The greatest frequency of bacterial isolation was observed in Brand 22 (75%). Of the total 88 samples analysed, 40.91% (n = 36) were positive for bacteria (*Escherichia coli* and Coliforms other than E. *coli*). Out of 88 samples collected, 20.45% (n= 18) revealed the presence of *Escherichia coli*. There was a statistically significant association between the Results of culture samples and different brand ($\chi 2$ = 19.000 ; p=0.000). The bacteria found in drinking water packaged in plastic bags suggest a risk of risk to human health from infection.

* **Corresponding Author:** Fadéby Modeste Gouissi ✉ gouissi@yahoo.fr

Introduction

The Malanville border crossing in northern Benin is one of the busiest in West Africa. In September and October 2023, it was at a standstill. Drivers stranded for weeks need water for a variety of reasons. Water is essential to human life as a natural resource that is beneficial for sustainable health (Mamta *et al.*, 2023 ; WHO, 2017). Various uses create the need for water at different times in humans (Mazzoni *et al.*, 2023). During travel, water is also a need for people on the move (Bhatta *et al.*, 2023). Nevertheless, to avoid waterborne diseases, food hygiene and drinking water, are important (Cailhol and Bouchaud, 2007).

Some travel conditions can create an unprecedented challenge for water, sanitation and hygiene needs (Islam and Nuzhath, 2018). Travel sometimes requires people to buy drinking water packaged in a variety of containers, including cans, plastic boxes and bags (WHO., 2017).

The failure of food hygiene in general and drinking water in particular, leads to a health risk of microbial contamination (Bhatta *et al.*, 2023 ; Cailhol and Bouchaud, 2007). A poor quality water supply in a population could lead to waterborne diseases, diarrhoea (WHO., 2017). Infectious diseases caused by pathogenic bacteria, viruses and parasites are the most common health risk associated with drinking water (WHO., 2017). These waterborne diseases of microbial origin can affect millions of people (Mamta *et al.*, 2023).

In India from 2014 to 2018, diarrhoeal diseases, typhoid, cholera, hepatitis and shigellosis are common waterborne diseases, responsible for an estimated 11 728 deaths (Mamta *et al.*, 2023).

The prevalence of waterborne diseases, including diarrhoea, cholera, typhoid fever and dysentery, has been mainly attributed to unsafe water, poor hygiene (Pande *et al.*, 2018).

Control measures and monitoring of the microbial quality of drinking water are necessary for the safety of the population. Verification of the microbial quality of drinking water, including testing for *Escherichia coli*, and Coliforms other than E. *coli* (WHO., 2017). The extent of faecal pollution is an important factor in assessing water quality and the risk of infection to humans (ISO 9308-1, 2014).

Escherichia coli, and Coliforms other than E. *coli* should be completely absent from drinking water (WHO., 2017). The objective of this study is to evaluate the bacteriological profile of drinking water packaged in plastic bags sold to travellers stranded at Malanville border crossing in northern Bénin.

Materials and methods

An analytical cross-sectional study was carried out from drinking water packaged in plastic bags sold to travellers stranded at Malanville border crossing in northern Benin, in order to identify the presence of bacterial (*Escherichia coli* and Coliforms other than E. *coli*).

Bacteriological testing was carried out at the Laboratory of Food Microbiology, Ministry of Health (Bénin). The Study period was September 04 to October 18, 2023.

Sample collection

A total of 88 samples of drinking water packaged in plastic bags were randomly collected from water traders at the site of stranded travellers at the Malanville border crossing in northern Benin.

21 different brands of drinking water packaged in plastic bags were collected at a rate of 4 samples per brand. One drinking water packaged in plastic bags without Producer Identification was found, and 4 samples were collected.

The different marks were numbered from 1 to 22. Number 22 refers to samples without producer identification.

The resulting samples were packed in a cooler and sent to the laboratory (ISO 5667-3, 2004).

Sample processing

Filtration of 250 ml of the sample through a membrane filter, which retains the organisms, and placement of the membrane filter on a chromogenic coliform (Gélose RAPID'E.*coli* 2) (ISO 9308-1, 2014).

RAPID' E.*coli* 2 is a selective chromogenic agar used for direct enumeration, without confirmation, of *Escherichia coli* and other coliforms in water. Incubation of the membrane filter at (36 ± 2) °C for (21 ± 3) h (ISO 9308-1, 2014).

Counting positive colonies: for Coliforms other than E. *coli* « beta-D-galactosidase (GAL) +/ P-D-glucuronidase (GLUC) -», form blue to green colonies, whereas, specifically, E. *coli* « beta-D-galactosidase (GAL)+/ P-D-glucuronidase (GLUC) +» form violet colonies.

From the number of confirmed colonies counted on the filter membrane, the total number of Coliforms was made (ISO 9308-1, 2014).

Statistical analysis

The results of bacteriological analyses were compared with the WHO Guideline Values for the quality of human drinking water.

All statistical analyses were performed using SPSS Statistics 21 software. A Chi Square Test was used to test the association between the Results of culture samples and differents samples of drinking water packaged in plastic bags at a 0.05 level of significance.

Results

The number of samples collected was 4 per brand, and the table 1 presents the result of a total of 88 samples analysed.

Of the total 88 samples analysed, 40.91% (n = 36) were positive for bacteria (Table 1). The greatest frequency of bacterial isolation was observed in Brand 22 (without producer identification) (75%) and the absence of bacteria was noted in Brand 1, Brand 13, Brand 14 and Brand 17 ($\chi 2 = 19.000$; $p=0.000$).

Out of 88 samples collected, 20.45% (n= 18) revealed the presence of *Escherichia coli* (table 2) ($\chi 2 = 23.000$; $p = 0.000$).

Table 1. Results of culture samples.

Brand Number	Positive results
Brand 1	0
Brand 2	2 (50%)
Brand 3	1(25%)
Brand 4	2 (50%)
Brand 5	1 (25%)
Brand 6	2 (50%)
Brand 7	2 (50%)
Brand 8	2 (50%)
Brand 9	3 (75%)
Brand 10	1 (25%)
Brand 11	3 (75%)
Brand 12	2 (50%)
Brand 13	0
Brand 14	0
Brand 15	2 (50%)
Brand 16	2 (50%)
Brand 17	0
Brand 18	2 (50%)
Brand 19	2 (50%)
Brand 20	2 (50%)
Brand 21	2 (50%)
Brand 22 (without producer identification)	3 (75%)
Total	36 (40.91%)

Of the total 88 samples analysed, 40.91% (n = 36) were positive for Coliforms other than *E. coli* (Table 3) ($\chi 2 = 19.000$; $p=0.000$).

Discussion

Consumption of contaminated drinking water continues to cause significant human disease in both developed anddeveloping countries. The presence of faecal pollution is an important factor in assessing the quality of water and the risk to human health from infection (ISO 9308-1, 2014). Examination of water samples for the presence of *Escherichia coli* (E. *coli*), which normally inhabits the bowel of man and other warm-blooded animals, provides an indication of such pollution (ISO 9308-1, 2014).

Samples of drinking water packaged in plastic bags were used for the identification of *Escherichia coli* and Coliforms other than E. *coli* in this study. From a

total of 88 Samples of drinking water packaged in plastic bags, there were 40.91% positive bacterial cultures. There was a statistically significant association between the Results of culture samples and different brand ($\chi 2 = 19.000$; $p=0.000$).

Table 2. Distribution of *Escherichia coli* identified according to different brands.

Brand Number	Positive results
Brand 1	0
Brand 2	1 (25%)
Brand 3	0
Brand 4	1 (25%)
Brand 5	0
Brand 6	1 (25%)
Brand 7	1 (25%)
Brand 8	1 (25%)
Brand 9	3 (75%)
Brand 10	0
Brand 11	1 (25%)
Brand 12	2 (50%)
Brand 13	0
Brand 14	0
Brand 15	2 (50%)
Brand 16	0
Brand 17	0
Brand 18	2 (50%)
Brand 19	1 (25%)
Brand 20	1 (25%)
Brand 21	0
Brand 22 (without producer identification)	1 (25%)
Total	18 (20.45%)

The distribution of the results obtained from the culture of the samples in this study, reflected the level of efficiency of the treatment of the drinking water packaged in plastic bags generally sold to populations. This presence of coliform bacteria, may indicate failure in treatment, storage (ISO 9308-1, 2014 ; Dieng *et al.*, 2021). These data encourage a strengthening of the principles of treatment, storage, or distribution drinking water packaged in plastic bags. The presence of coliform bacteria in drinking water packaged in plastic was also found in 2021 by Dieng *et al.* (2021).

Escherichia coli accounted for 20.45% (n=18) in this study. *Escherichia coli* is a formidable pathogen in certain infections, including those of the urinary tract (Eman *et al.*, 2018), sepsis, pneumonia, neonatal meningitis (Hassan *et al.*, 2015, Lausch *et al.*, 2013).

Table 3. Distribution of Coliforms other than E. *coli* identified according to different brands.

Brand Number	Positive results
Brand 1	0
Brand 2	2 (50%)
Brand 3	1 (25%)
Brand 4	2 (50%)
Brand 5	1 (25%)
Brand 6	2 (50%)
Brand 7	2 (50%)
Brand 8	2 (50%)
Brand 9	3 (75%)
Brand 10	1 (25%)
Brand 11	3 (75%)
Brand 12	2 (50%)
Brand 13	0
Brand 14	0
Brand 15	2 (50%)
Brand 16	2 (50%)
Brand 17	0
Brand 18	2 (50%)
Brand 19	2 (50%)
Brand 20	2 (50%)
Brand 21	2 (50%)
Brand 22 (without producer identification)	3 (75%)
Total	36 (40.91%)

Conclusion

Bacterial identification in drinking water packaged in plastic is important in assessing the quality of water and the risk to human health from infection. Here, we report the pathogens present in water packaged in plastic bags generally sold to populations. These data indicate failure in treatment and storage drinking water packaged in plastic.

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