

Drilling Water Quality Used on the Campus of Abomey-Calavi in Bénin.

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Abstract.

One of the Millennium Development Goals is the satisfaction of needs of drinking water for all social strata. In this context, the subsequent challenge to mobilization is the question of quality of water supply. The present study that focuses on the student population of the largest campus of Benin was conducted to assess the quality (chemical and bacteriological) of the water served to them by the drinking water supply system. Preliminary investigations revealed that the water is not treated before being distributed. Thirty (30) samples were taken at various levels of the distribution network and analyzed. Chemical parameters were evaluated by chromatography and bacteriological parameters according to standard methods of the Beninese Agency for Standardization (ABeNor). The results were discussed in comparison with national and World Health organization (WHO) standards. The results lead to chemical compliance (nitrate, nitrite, phosphate, sulphate, ammonia, calcium, potassium, sodium, magnesium, bicarbonate, chlorine). In bacteriological terms, compliance was 100% for *E. coli* and streptococci, but for other germs, it was 6.67% (Flora aerobic revivifiable), 36.66% (Total *Coliforms*) and 90% (*Clostridium perfringens*). Apart from the two (02) samples taken directly from the water castle, the rest were found not to comply. Thus, the results of bacteriological analysis revealed that the quality of the water supplied on the largest Campus of Benin is unsafe and risky when we consider the huge amount of the student population that uses it. However, this can be easily corrected by implementing a maintenance and disinfection plan of the water distribution network.

Keywords: borehole water, chemical analyses, bacteriological analyses, water risk.

1. INTRODUCTION

Water is a vital natural resource and is one of the most sensitive and fragile natural resources. It is an economic and social development factor that has no substitute. Water, the source of life, can become a source of diseases from its bacteriological and/or chemical quality. Therefore, drinking water must meet the criteria of hygienic, chemical and organoleptic quality [1]. When drinking water does not meet quality standards, It can cause waterborne infections [2], [3], [4], [5], [6], including cholera, bloody diarrhea, dysentery, hepatitis, bone disease, dental, neuromuscular, renal, abnormal heartbeats, typhoid fever and some viral diseases.

On the campus of Abomey-Calavi, there is, to date, no recent scientific data on the quality of water supplied through the distribution system. Therefore, this study focuses on the drilling water quality distributed on this campus not only to fill the lack of data but also given to the size of its student population (more than 70,000 students in 2011).

2. DATA AND METHODS

The campus of Abomey – Calavi is located in the city of Abomey-Calavi about 15 km from Cotonou the economic capital of Benin Republic. Data used are concentrations of chemical compounds including nitrites, nitrates, phosphates, sulfates, ammonium, calcium, magnesium, potassium, sodium and chlorine recorded for 30 samples in the water distribution network (Figure 1). These concentrations are determined by chromatography according to the AFNOR method (NFT90-042 year 1998), using the Dionex ICS-1000 Chromatograph. Bicarbonates were also measured and the total organic load was obtained by KMnO_4 oxidizability.

Microbiological parameters such as Aerobic Revivable Flora (ARF), Total Coliforms (TC) and Thermotolerant (CTh: *Escherichia Coli* (*E. coli*), *Clostridium* and Anaerobes Sulphite-Reducing (ASR)) were investigated by seeding a part 1 ml of sample and secondly filtering on a 0,45µm pore membrane [7] homogeneous aliquots of 20 and 100 ml diluted in sterile peptone water to obtain a number of Unit Colony Forming (UCF) of between 30 and 300. The membranes were then placed on selective materials from Bio-Mérieux Laboratories for 24 hours at 37 ° C and 44 ° C. The colonies (UCF) were then counted.

The results for the drinking water chemical as well as bacteriological quality were interpreted based on the Bénin national criteria [8] and the WHO year 2004 one.

Figure 1: Sampling points localization on the campus.

3. RESULTS AND DISCUSSIONS

It is found that the drilling water of the campus of Abomey-Calavi is not treated before distribution. It is used for all domestic purposes by students accommodated in halls of residence or near the campus, the administrative and academic staff, as well as users of shopping centers. This water is further used for distilled water production in laboratories and for gardening.

The results of different analyses related to chemical parameters measured (Table 1) clearly show that there are no nitrites, phosphorus, ammonium, or chlorine in the distributed water. However, we noticed the presence of nitrates in the water consumed on the campus. But their levels are compatible with the criteria of water potability used [8]. Other chemicals such as sulfates calcium, magnesium and bicarbonates are also found to be in acceptable proportions. Furthermore, the total organic load obtained by KMnO_4 oxidizability varies between 0 and 0.26 mg/l.

The presence of nitrates in the water samples (Table 1) is a sign of chemical pollution that could be related to infiltration/intrusion of wastewater [9] of human origin or drain oils, greases, hydrocarbons which are spilled on the floor in the garage of the Polytechnic School of Abomey - Calavi (EPAC), student outdoor urine, and pet droppings (especially cattle of the Agricultural Sciences Faculty (FSA)). All these pollutants can be driven by rainwater infiltration into the ground and take part in a complex set of reactions releasing nitrates.

Furthermore, bacteriological analyses (Table 2) show that apart from the two samples directly from the borehole and the water tower, all others samples are not satisfactory according both to Beninese and WHO standards. Indeed, for all samples, the number of UCF Aerobic Revivable Flora (ARF)/ ml ranging from

36 to $2,6 \cdot 10^6$ UCF/ml while that of Total Coliforms (TC) is between 0 and 10^3 UCF/ml. Anaerobic sulphite

Reducing (ARS) concentrations vary between 0 and 11 UCF/ml. In contrast, *E. coli* and Streptococci are

absent. The presence of ARF proves that there is a biological pollution in the distribution network due primarily to the ARF and Total Coliforms (TC), which maximum concentrations are respectively $2,6 \cdot 10^6$ UCF/ml (at the university restaurant) and 10^3 UCF (at the Agronomical Sciences faculty Laboratory). The absence of chlorine that is a disinfectant in the water, justifies the presence of the ARF and Total Coliforms.

Table 1. Chemical quality of sampled water.

Sampling points Codes	Chemical parameters measured concentrations										
	NO ₂	NO ₃	PO ₄	SO ₄	HCO ₃	NH ₄	Ca	Mg	K	Na	Cl
C ₁	0	3,146	0	11,05	13,35	0	8,050	6,54	0,750	50,35	0
C ₂	0	3,146	0	11,04	13,34	0	8,040	6,54	0,760	50,36	0
CS ₁	0	3,148	0	11,04	13,35	0	8,090	6,54	0,770	50,38	0
LF ₁	0	3,236	0	11,29	10,06	0	8,115	6,33	0,680	50,35	0
LF ₂	0	3,227	0	10,40	18,8	0	10,720	7,57	0,685	51,21	0
LF ₃	0	3,238	0	11,44	18,8	0	8,433	6,42	0,637	51,40	0
LE ₁	0	3,209	0	11,07	18,8	0	8,024	6,60	0,633	49,12	0
LE ₂	0	3,106	0	11,02	33,58	0	7,991	6,70	0,651	49,88	0
LE ₃	0	3,220	0	11,27	18,00	0	7,967	6,71	0,633	49,13	0
LS ₁	0	3,179	0	11,06	23,68	0	7,546	6,11	0,590	44,86	0
LS ₂	0	3,148	0	10,92	10,04	0	8,578	7,10	0,658	52,24	0
LS ₃	0	3,240	0	10,07	10,03	0	8,574	7,01	0,658	51,21	0
FF	0	3,262	0	11,08	38,32	0	8,526	6,50	0,640	48,83	0
FL	0	3,201	0	11,05	38,31	0	9,040	6,40	0,641	52,24	0
S	0	3,150	0	10,96	38,21	0	9,333	6,48	0,616	51,21	0
RUP ₁	0	3,200	0	10,87	38,15	0	9,627	6,50	0,633	51,40	0
RUA	0	3,041	0	10,89	10,01	0	9,920	7,08	0,651	48,83	0
CCE	0	3,201	0	10,92	9,56	0	8,072	6,62	0,642	49,03	0
CCR ₁	0	3,263	0	11,23	8,28	0	7,885	6,46	0,656	48,90	0
CCR2	0	3,211	0	10,94	12,92	0	7,913	6,53	0,633	49,31	0
CCER1	0	3,219	0	11,18	18,80	0	7,824	6,31	0,642	48,47	0
CCER2	0	3,527	0	11,03	38,32	0	7,924	6,46	0,618	49,02	0
CP	0	3,232	0	12,51	10,50	0	8,103	6,49	0,694	50,70	0
CM1	0	3,336	0	11,13	13,92	0	11,19	6,81	0,668	50,84	0
CM2	0	3,451	0	11,12	13,40	0	7,824	6,62	0,642	48,03	0
CI	0	3,220	0	11,71	13,21	0	7,924	6,46	0,637	53,01	0
CB	0	3,201	0	11,25	13,25	0	8,024	6,11	0,590	49,40	0
TS1	0	3,145	0	10,44	13,92	0	7,991	7,10	0,658	53,07	0
TS2	0	3,205	0	10,50	13,65	0	7,967	7,57	0,685	52,05	0
INF	0	3,200	0	10,51	13,58	0	7,983	6,46	0,637	47,63	0
CMA*	3,2	45	5	500	--	0,5	100	50	--	--	250
Minimum	0	3,041	0	10,04	8,28	0	7,546	6,11	0,590	44,86	0
Mean	0	3,216	0	11,05	18,68	0	8,439	6,64	0,660	50,06	0
Maximum	0	3,527	0	12,51	38,32	0	11,19	7,57	0,770	53,00	0
% of C	100%	100%	100%	100%	--	100%	100%	100%	--	--	100%

CMA* : Maximum concentration authorized according to Beninese standards (ABENOR, 2001).

-- : non specified.

% de C : pourcentage of conformity.

Then a network disinfection treatment is necessary to eliminate the risk of food poisoning on the campus of Abomey-Calavi.

Table 2. Bacteriological quality of water supplied on the Abomey - Calavi campus

Sampling points Codes	Bacteriological parameters					Conclusion
	Aerobic Flores	Total Coliforms	C. Th (<i>E. coli</i>)	Streptococci	ASR	
C₁	36	<1	<1	<1	<1	Satisfactory
C	48	5	<1	<1	<1	
	Satisfactory CS		2.10 ²	47	<1	<1
	<1	Not Satisfactory				
LF	4,8.10 ⁵	<1	<1	<1	<1	Not
Satisfactory LF	1,1.10 ²	5	<1	<1	<1	Not
Satisfactory LF	5,7.10 ⁴	3.10 ²	<1	<1	<1	Not
Satisfactory LE	7,5.10 ⁴	3.10 ²	<1	<1	<1	Not
Satisfactory						
LE	1,7.10 ⁴	1,26.10 ²	<1	<1	<1	<1
Satisfactory LE		1,25.10 ⁴	<1	<1	<1	<1
						Not Satisfactory
LS	1,6.10 ³	1,01.10 ²	<1	<1	<1	Not
Satisfactory LS	4,9.10 ⁴	1,72.10 ²	<1	<1	<1	Not
Satisfactory LS	3,5.10 ³	10 ³	<1	<1	<1	Not
Satisfactory						
FF	2,7.10 ⁵	9	<1	<1	<1	5
Satisfactory FL		4,4.10 ⁵	62	<1	<1	<1
						Not Satisfactory
S	9,6.10 ⁵	2	<1	<1	<1	Not
Satisfactory RUP₁	3,7.10 ⁵	19	<1	<1	<1	Not
Satisfactory RUA	2.6.10	54	<1	<1	<1	Not
Satisfactory CCE	1,9.10 ⁵	3.10 ²	<1	<1	<1	Not
Satisfactory						
CCR	1,2.10 ⁴	11	<1	<1	<1	<1
Satisfactory CCR₂		1,82.10 ⁴	<1	<1	<1	<1
						Not Satisfactory
CCER	5,1.10	54	<1	<1	<1	Not
Satisfactory CCER		1,1.10 ⁴	3.10 ²	<1	<1	<1
	Not Satisfactory CP		1,5.10 ³	16	<1	<1
	<1	Not Satisfactory CM	6,5.10 ⁴	03	<1	<1
	<1	<1	Not Satisfactory			
CM	4,2.10 ⁵	03	<1	<1	<1	<1
Satisfactory CI		1,4.10 ⁵	46	<1	<1	<1
						Not Satisfactory
CB	5.10 ⁴	63	<1	<1	<1	Not
Satisfactory TS		1,5.10 ⁴	2,24.10 ²	<1	<1	<1
	Not Satisfactory TS		1,6.10 ⁴	5	<1	<1
	<1	Not Satisfactory INF	3,4.10 ⁴	12	<1	<1
	<1	<1	Not Satisfactory			
CMA*	50,00	10	<1	<1	<1	<1
	<1 Minimum	36,00	<1	<1	<1	<1
	<1	0 Mean	2,15.10 ⁵	108		
	<1	<1	0,566 Maximum	2,6.10 ⁶		
10 ³	<1	<1	11 CMA*: Maximum authorized			

according to the Beninese standards (ABENOR, 2001).

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