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# Physico-Chemical and Bacteriological Characterization of the Ablution Waters of Public Toilets in the Municipality of Yopougon (Abidjan)

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**A B S T R A C T**

Ablutions in public toilets present many risks to the health of populations. Thus, data were collected to assess the quality of these waters. To do this, electrochemical and spectrophotometric methods were determined for the analysis of classical physico-chemical parameters. The bacteriological parameters were determined by the membrane filtration technique. Based on the results obtained, the parameters involved are residual chlorine (0.09 mg/L), turbidity (1.88 UNT), *E. coli* (3 CFU/100 ml), total coliforms (53 CFU/100 ml). Therefore, the low degree of disinfection is characteristic of these public latrine ablution waters. This leads to the emergence of *Escherichia coli*, which pose enormous risks to population health. As a palliative solution, sanitary surveillance of these waters used for ablution is therefore necessary to preserve the health of populations.

## Introduction

Water in general is used in many areas of activity (Festy *et al.*, 2003) as well as for personal hygiene purposes and requires a high level of quality for its use (Degbey *et al.*, 2008). Water plays a key role in socio-economic development and policies to protect the health of living things (WHO, 2008). In the majority of developing countries, it is a major problem that hinders economic development (Chouti, 2007). According to the work of Karim *et al.*, (2002), more than one billion people do not have access to drinking water either because of its scarcity or because of its poor quality. This may result in the presence of many germs in the water that may have adverse health effects (Angulo *et al.*, 1997).

Indeed, according to the WHO (2007), in Africa every year 1, 8 million people, 90% of whom are children under five, die of diarrhoeal diseases. Africa and Asia are not on the margins of these

types of problems. On these continents, drinking water is inaccessible to most people (Bengaibona, 2010).

In Côte d'Ivoire in particular, access to drinking water and sanitation is a problem for many people who live mainly in urban and peri-urban areas (Tuo, 2010). Water used in latrines for ablutions is usually stored in drums (Bohoussou, 2019).

Thus, water storage and use conditions expose people to waterborne diseases. To this end, data were collected to assess the risk to the population of the quality of these waters. The objective is to stimulate health awareness in order to preserve the health of populations.

## Materials and Methods

### Equipment

### Presentation of the study area

This study is conducted in the commune of Yopougon (Ivory Coast) located west of the city of Abidjan between 5°20'56' in the north and 4°00'42' in the west. It covers 153.06 km² and includes 22.75% of the population of Abidjan, or 1071543 inhabitants (Diabaté *et al.*, 1991) (Figure 1).

### Equipment

The main measuring equipment consists of a pH meter, a conductivity meter, a turbidity meter, a Palintest photometer (Great Britain), for physicochemical parameters and a membrane filtration device for bacteriological parameters.

### Sampling

Sampling campaigns focused on water used for ablutions in 30 public latrines distributed over 16 markets in the municipality of Yopougon. Samples were taken in 1000 ml polyethylene bottles for physicochemical parameters and 500 ml for microbiological parameters. The reagents for measuring chemical parameters were PALINTEST (Great Britain). BIORAD Rapid'E. coli 2 Agar, BEA (Bile Esculine Azide) and TSN (Tryptone Sulfite Neomycin) culture media were used to count fecal contamination markers.

### Reagents

The reagents used were analytical grade. The chemical parameter measurement reagents were Palintest (Great Britain). Rapid'E. coli 2 Agar, BEA agar (Bile Esculine Azide) and BIORAD brand TSN (Tryptone Sulfite Neomycin) culture media were used to count fecal contamination markers.

### Collection, transport and storage of samples

Samples were collected according to WHO/UNEP recommendations. The samples were stored in a cooler protected from light at a temperature between 4°C and 8°C and transported to the laboratory while respecting the cold chain by ice accumulators**.**

### Physico-chemical analyses

The physicochemical parameters were determined by the following methods:

- titrimetry was used to determine organic matter (AFNOR, 1997).
- Turbidity is determined by type nephelometry (HACH, 1990).
- pH is measured with a HACH-type digital laboratory pH meter equipped with a combined electrode (Bioblock Scientific) (AFNOR, 1997).
- Conductivity is measured using a type conductivity meter (HACH, 1990).
- Mineral salts and colour were determined by colorimetry using a Palintest 7100 SE photometer with pre-set filters and calibration curves. Operational wavelengths range from 410 nm to 640 nm. The mineral salts sought were nitrites, nitrates, fluorides, iron, manganese, complete alkalimetric titer (TAC), total hydrometric degree (DHT), ammonium, sodium, magnesium, calcium, sulphates, potassium, bicarbonate, zinc.

## Microbiological Testing

Microbiological analyses identified and counted total coliforms (CT), thermotolerable coliforms (CTh), *Escherichia coli* (*E. coli), Enterococcus faecalis (E. faecalis), Pseudomonas* sp and sulphito-reducing anaerobic germs. These microorganisms were identified and counted by filtering homogeneous aliquots of 100 ml and 50 cl (sulfito-reducing anaerobic germs) on a membrane with a pore diameter of 0.45µm. The membranes were then placed on selective culture media for 24 hours at 37°C in the thermo-controlled oven.

The following media were used: BEA (Bile Esculine Azide) agar (Selective medium used for isolation and counting of enterococci by the classical method of Petri dish counting) for fecal Streptococci, Rapid'*E. coli* 2 Agar (culture medium for *E. coli* identification) for total coliforms, TSN agar (Tryptone Sulfite Neomycin) for Clostridium sulfito-reducer and pseudosalt or ketrimide medium for Pseudomonas.

## Data processing

A descriptive analysis (mean, median, minimum, maximum and standard deviation) of the contents of the parameters measured on the water of public toilets are presented. The statistical analysis was carried out and revealed the existing correlations between the different water parameters.

## Results and Discussion

## Physicochemical and bacteriological characterization of ablution waters

## Physico-chemical parameters

The results of the physico-chemical analyses of the ablution waters are entered in Table 1

Ablution waters have a pH below 6.5 for some samples and low mineralization with conductivity around 193.59 µS/cm on average. The maximum temperature is above 25°C and the residual chlorine is above the norm (0 mg/L). These parameters are non-compliant with WHO recommendations.

## Bacteriological parameters

Maximum microbial loads varied depending on the nature of the germ. Thus, they were respectively 53 CFU/100 ml for total coliforms, 51 CFU/100 ml for thermotolerant coliforms and 3 CFU/100ml for *E. coli*.

Table 2 presents the results of bacteriological analyses of ablution waters.

## Analysis of non-conformities

This involves determining the non-conformities at the sample level and for each parameter measured. Table 3 shows the quality of water used for ablution in public toilets in Yopougon. Of the various water samples analyzed, nearly 90% are non-compliant.

Our study revealed that ablution waters have a normal pH on average, that is, between 6.5 and 8.5, WHO (2008). But 70% of the samples of these ablution waters analyzed have an acidic ph.

The acidity of drinking water poses no problem for the health of the consumer. However, acidic water stored in containers can become rich in heavy metals as a result of corrosion of metal and cement-based materials (Eblin *et al.*, 2014) and therefore pose a threat to consumer health.

Turbidity in this study presents values that meet the standards. Turbidity itself is not a dangerous parameter for humans. But, an abnormal turbidity would promote a proliferation of bacteria indicative of fecal contamination. Indeed, water with low turbidity has been shown to harbour fewer microorganisms (Pritchard *et al.*, 2020). These values obtained after analysis are contrary to those obtained by Hadef Djihad and Hasni Malika (2017) on well water in Cameroon (Hadef and Hasni, 2017).

**Table.1** Results of physico-chemical analyses of ablution waters

| Parameters | Min | Max | Méd | Moy ± Ɛ | WHO Standard |
|---|---|---|---|---|---|
| **pH** | 5,43 | 7,69 | 6,62 | 6,74±0.54 | **6,5-8,5** |
| **Temperature (°C)** | 24,8 | 29,9 | 26,1 | 26,27±1.07 | **≤ 25** |
| **Conductivity (µS/cm)** | 101,7 | 361,4 | 181,7 | 193,59±65,53 | **100-1000** |
| **Turbidty (UNT)** | 0,27 | 1,88 | 0,75 | 0,86±0,38 | **≤ 5** |
| **Residual chlorine (mg/L)** | 0 | 0,26 | 0,08 | 0,09±0,08 | **0** |
| **Organic matter** | 0,33 | 3,75 | 1,33 | 1,60±0,85 | **≤ 5,0** |
| **Nitrites (mg/L)** | 0 | 0,03 | 0,01 | 0,01±0.1 | **≤ 0,10** |
| **Nitrates (mg/L)** | 0,37 | 45 | 7,3 | 10,91±11.75 | **≤ 50** |
| **Ammonium (mg/L)** | 0,01 | 1,15 | 0,145 | 0,33±0.37 | **≤ 1,5** |

**Table.2** Résultats des analyses bactériologiques des eaux d'ablution

| Parameters | Min | Max | Méd | Moy ± Ɛ | WHO (2008) |
|---|---|---|---|---|---|
| **Total coliforms (CFU/100 ml)** | 0 | 53 | 0 | 6,0 ± 13.42 | **0** |
| **Thermotolerant coliforms (CFU/100 ml)** | 0 | 51 | 0 | 4,0 ± 11.78 | **0** |
| ***E.coli* (CFU/100 ml)** | 0 | 3 | 0 | 1,0 ± 0.66 | **0** |
| ***E. faecalis* (CFU/100 ml)** | 0 | 0 | 0 | 0,0 ± 0.00 | **0** |
| **Pseudomonas spp (CFU/100 ml)** | 0 | 0 | 0 | 0,0 ± 0.00 | **0** |
| **Anaerobic Sulfito-Reducers (CFU/100 ml)** | 0 | 0 | 0 | 0,0 ± 0.00 | **0** |

**Fig.1** Location of the commune of Yopougon

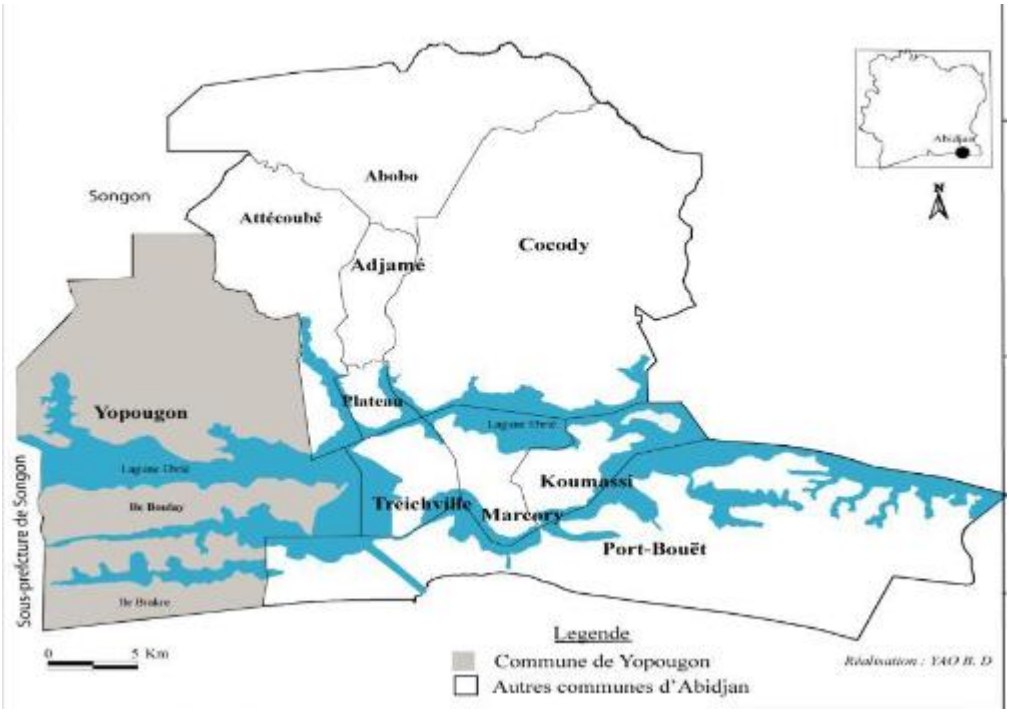

**Table.3** Non-conforming physicochemical and bacteriological parameters

| Samples | Number | Proportion |
|---|---|---|
| **Conforming** | 3 | 10% |
| **Non-conforming** | 27 | 90% |
| **Total** | 30 | 100% |

Les résultats des analyses ont montré que la majorité des échantillons sont non conformes.

Conductivity is used to assess the degree of mineralization of water as most dissolved matter in water is in the form of electrically charged ions (Rodier and Legube, 2009). For ablution waters, we have an average conductivity of around 100 µS/cm which shows that these waters are weakly mineralized. The values obtained between 49 and 129 µS/cm show that these waters do not comply with the standards.

For residual chlorine, the results were non-compliant in 86.67% of the samples analyzed. This very low rate can be explained by a lack of chlorination during production and by the storage of water in containers without lids. These results are similar to those obtained by Sackou (2010) with mean values of 0.13mg/L.

In terms of temperature, we have 93.33% of these ablution water samples with values ranging from 24.8 to 29.9°C with an average of 26.27°C. These results are close to those of Aïssi (1992) ; Comlanvi *et al.*, (1994) in Cotonou and Assani (1995) in Grand-Popo, where their work includes temperatures ranging from 25°C to 30°C. In addition, our study revealed levels of nitrogen derivatives in standards. This result could be explained by the hygiene measures adopted in the latrines. Indeed, the «kettles» used for ablution are not used for other needs and are filled only by the manager of public latrines. Also water in the «kettles» used for ablution is not exposed to contamination (Bohoussou, 2019).

Bacteriologically, the particular presence of *Escherichia coli* indicates fecal contamination of these waters (Chevalier, 2003). This contamination can be correlated with the lack of hygiene of the hands and the extraction equipment. Ablution waters are contaminated with bacteria indicative of fecal pollution. A study in Zimbabwe showed that just covering the water reservoir reduced total and fecal coliforms in water stored in households by 50% (Mazengia, 2014).

The poor quality of the stored water is close to the absence of disinfectant, characterized by low residual chlorine values, and water storage conditions (Kouadio *et al.*, 1998). These results are similar to those observed by Agassounou *et al.*, (2014) which found in their research that running water at the source is potable but contains total coliforms and fecal coliforms at storage.

The data collected during this study allowed to draw a portrait of the physico-chemical and microbiological quality of the waters. It appears from this study that the majority of ablution water samples analyzed are non-compliant. The parameters involved are residual chlorine, pH, temperature and coliforms. Bacteriologically, the presence of *Escherichia coli* is a major health risk for the population.

These different results have shown that ablution water in public latrines is characterized mainly by its very low disinfectant content (0.09 mg/ L) and its relatively high temperature, resulting in the presence of *Escherichia coli*. This poses a major health risk to the population.

To minimize the health risks associated with such practices, particular emphasis should be placed on the disinfection of ablution water and the promotion of hygiene in these places.

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