Survey of the Quality Physical, Chemical and Bacteriological of the Underground Waters of the Continental Terminal of the Township of Abomey-Calavi (Benin)

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Authors’ contributions

This work was carried out in collaboration between all authors. Author SPH designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript and managed literature searches. Authors DM and DS managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

ABSTRACT

Many campaigns of withdrawal of the underground waters have been done during the year 2013 to the level of the drillings situated in the township of Abomey-Calavi for control their quality. These withdrawals were the object of analysis according to the techniques of assessment of water quality described by Rodier (1978) and to the recommendations of the world organization of health (WHO). The physical and chemical analysis showed that the concentrations of the 98.7% of the studied drillings are superior to the norms recommended by the WHO (1994) and by Benin (2011). The studied drillings present without exception a bacteriological pollution. The very elevated microbial

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National Society of the Waters of Benin (SONEB)
watering of the animals and for the
irrigation. The
The vulnerability of resources to a possible
factor, the necessary measures to develop,
to manage and to protect resources.

In Benin the underground waters constitute a
part important of the hydraulic heritage of the
country, because of its relatively easy
exploitation. The underground waters are
traditionally resources in water privileged for the
drinking water, because more safe from the
pollutants that the waters of surface. In the
targeted region, the underground waters were always a source important of provision in drinking
water for the local populations and, for the
watering of the animals and for the irrigation. The
National Society of the Waters of Benin (SONEB)
to achieved in the precinct of Godomey in the
township of Abomey-Calavi; of the drillings of
which it exploits intensively the underground
waters of the continental terminal that it treats to
nourish in drinking waters the urban populations
of the township of Abomey-Calavi; the whole
population of Cotonou, biggest city of the country
and to nourish in drinking waters the population
of the city of Sèmè. However the quality of water
represents a growing preoccupation. The
challenge to which copes all regions of Benin
and particularly the farming zones is the
protection of the quality of resources in
underground water. Indeed, the underground
water pollution represents one of the most
troubling aspects and the use of these waters for
drinking represents a danger for health [1]. The
present work is interested in the survey of the
physical, chemical and bacteriological quality of
the underground waters of the water table of the
continental terminal in the Township of
Abomey-Calavi.

2. MATERIALS AND METHODS

2.1 Sampling

Every drill existing in the township of Abomey-
Calavi before the launching of this survey in
January 2013 have been sampled to have a
general picture of the water table of the
continental terminal. We did to the total seventy
seven withdrawals to the level of seventy seven
drilling for the physical and chemical analysis.
For the bacteriological analyses we have
sampled nine drillings at the rate of a drilling by
precinct of the township.

2.2 Region of Survey

The township of Abomey-Calavi counts seventy
(70) villages and districts of cities distributed on
nine (09) precincts that are: Calavi-Centre,
Godomey, Akassato, Zinvié, Ouédéo, Togba,
Hêvié, Kpanroun and Glo-Djigbé (Figs. 1 and 2).
The township of Abomey-Calavi, situated in the
South part of Republic of Benin, is limited at the
North by the township of Zè, to the South by the
Atlantic Ocean, to the East by the townships of
Sô-Ava and Cotonou and to the west by the
townships of Tori-Bossito and Ouidah. It is the
vast township of the department of the Atlantic
of which it occupies more than 20% of the surface.
It spreads on a surface of 536 km² representative
0.48% of the national surface of Benin. The
township of Abomey-Calavi is very close to the
biggest plan of water Beninese lagoon: The
Nokoué lake. Indeed, Long of 20 km (East-west)
and wide of 11km (North - South), the Nokoué
lake has a surface of low water of about 160 km²
and represent the largest plan of water in Benin
and most important lagoon because of its
proximity with the city of Cotonou. The Nokoué
lake influences considerably the underground
water pollution close to him [1].

2.3 Physical and Chemical Parameters
Analyzed

The survey has been led on seventy seven
samples of water coming from the seventy seven
drillings in the township of Abomey-Calavi. The
withdrawals of the samples for the physical and
chemical analysis have been put in small bottles
in plastic then routed to the laboratory for the
analysis. The physical and chemical analysis
concerned the parameters following: TDS, color,
hardness, pH, electric Conductivity, temperature,
calcium, magnesium, total iron, ammonium,
carbonate, chloride, sulphate, nitrate, nitrite,
phosphate, turbidity, fluoride (Table 1).
Fig. 1. Location of the municipality of Abomey-Calavi
2.4 Microbiological Analyses

During our work, we measured some indicators micro organisms of pollution: The total coliforms; the coliforms thermotolerants and the intestinal enterococci have been measured by the method of incorporation on agar.

The material consists of autoclave, incubators, and cultures mediums whose Rapid E. coli to identify total coliforms and thermotolerant coliforms and Slatnez Bathley to identify intestinal enterococci.

As part of these studies, we applied the method by incorporation into agar. It consists of taking a given volume of drilling water sample using a syringe that is incorporated in the non-solidified agar. As part of our study we included 1 ml.
As part of these studies, we applied the method by incorporation into agar. It consists of taking a given volume of drilling water sample using a syringe that is incorporated in the non-solidified agar. As part of our study we included 1 ml.

According sought germs, the culture medium and incubation temperatures are:

- Research and identification of total coliforms and thermotolerant coliforms:

  The culture medium used is the Rapid'E coli. It will detect coliforms in 24 hours (total coliforms and thermotolerant coliforms) in a sample. It is an agar whose active ingredient acts on coliform enzymes and color to blue (thermotolerant and total coliforms).

  As part of our study, incubation was done at 44°C for thermotolerant coliforms. Incubation was done at 37°C for total coliforms.

- Research and identification of intestinal enterococci:

  The culture medium used for their research and their identification is the culture medium Slatnez Bathley. In the presence of intestinal enterococci, colonies appear in red on the agar after incubation at 37°C in 24 to 48 hours.

3. RESULTS AND DISCUSSION

3.1 Physical and Chemical Quality of Water

3.1.1 TDS

It is essentially solid minerals in the water: Calcium, magnesium, sodium, bicarbonates, chlorides and sulphates; they confer to water its taste [2]. The TDS informs on the mineralization of a water. The saltness of waters can also be represented by the TDS that corresponds to the sum of the concentrations of the major chemical elements (Ca\(^{2+}\), Na\(^{+}\), Mg\(^{2+}\), K\(^{+}\), Cl\(^{-}\), SO\(_4\)^{2-}, NO\(_3\)^{-}, and HCO\(_3\)^{-}) [3]. In the case of the survey region, the TDS of the waters of the ground water of the continental terminal varies a 13 mg/L, in the drilling F\(_{76}\); to 2,020 mg/L, in the drilling F\(_{40}\) (Fig. 3). It is to note that the value of the TDS of the waters of F\(_{40}\) drilling is extensively superior to those of the other drilling waters.

3.1.2 The hardness

The total hardness of a water is produced by the salts of calcium and magnesium that it contains. One distinguishes: a hardness carbonated that corresponds to the content in carbonates and bicarbonates of that and Mg and a toughness non-carbonated produced by the other salts. The hardness is measured by the title hardness expressed in °F (French degree); 1°F correspond to 10 mg of Calcium carbonate in 1 liter of water. It results mainly from the contact of the underground waters with the rocky formations: The calcium drifts of the attack of the CO\(_2\) dissolves by the chalky rocks (dolomites) or of the dissolution under shape of sulphate in gypsum. The hardness of a natural water depends on the geological structure of soils. In the analyzed samples (Fig. 4), this parameter presents a big variation of a drilling to other that would be bound of the geological formation of the water and in particular to his composition in magnesium and in calcium [4]. The hardness of the survey zone varies 6 mg/L, in the drilling F\(_{41}\), F\(_{53}\) and F\(_{76}\) to 430 mg/L, in the drilling F\(_{40}\). According to the Beninese legislation, the

Table 1. Measuring apparatus and methods of physical and chemical parameters

| Parameters studied                                      | Measuring apparatus and methods                                      |
|---------------------------------------------------------|---------------------------------------------------------------------|
| pH, temperature, dissolved oxygen                       | Direct measurement by multi parameter PC                            |
| Conductivity, total dissolved solids                    | WATER QUALITY CHECKER HORIBA U-10                                   |
| Turbidity                                               | Direct measurement by multi parameter                              |
| Chemical parameters (NO\(_2\)^{-}, NO\(_3\)^{-}, NH\(_4\)^{+}, Ca^{2+}, Mg^{2+}, Cl\(^{-}\), CO\(_3\)^{-}, SO\(_4\)^{2-}, HCO\(_3\)^{-}, total PO\(_4\)^{3-}) | Conductivity WTW 340 i                                             |
|                                                         | HACH colorimeter / 890, Method 8025                                 |
|                                                         | Chromatographic Method ICS 1000                                     |
hardness of a water destined to the consumption must be less than 200 mg/L [5]. The hardness of all waters sampled is compliant to the norms of Benin accept the drilling F40 and the drilling F71.

### 3.1.3 PH

This parameter measures the acidity or the alkalinity of a water. It translates the balance thus between acid and basis on a scale of 0 to 14, 7 being the pH of neutrality to 25°C. This parameter characterizes a big physical and chemical balance number and depends on multiple factors, of which the origin of water. The natural water pH is bound to the nature of rocks crossings. In most natural waters, of the pH is consisted usually between 6 and 8.5 whereas in the tepid waters, this one is understood between 5 and 9 [6]. The values of pH admitted for a drinking water by the WHO are consisted between 6.5 and 8.5. In the case of the survey region, the values of the pH of the waters of the water table of the continental terminal show sensitive variations, with a minimum of 4.12 to the drilling F51 and a maximum of 7.67 in the drilling F40 (Fig. 5). 92.20% of the pH measured are lower to the lower value admitted by the

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**Fig. 3. Variation spatial of the values of the TDS**

**Fig. 4. Spatial variation of the values of the total hardness**
WHO for a drinking water. This acidity of the waters of the water table is probably owed to soil.

3.1.4 Conductivity

Conductivity measures the capacity of water to drive the current between two electrodes. Most matters dissolved in water are under shape of ions. The measure of the conductivity permits to appreciate the quantity of salt dissolved therefore. The electric conductivity depends on loads of endogenous and exogenous organic matter, generating of salts after decomposition and mineralization and also with the phenomenon of evaporation that concentrates these salts in water, it varies as according to the crossed geological substratum. In the case of the survey region, the values of the electric conductivity of the waters of the ground water of the continental terminal show sensitive variations, with a minimum of 27 µS/cm to the drilling F76 and a maximum of 574 µS/cm in the drilling F71 (Fig. 6). The values of the conductivity of the waters of the ground water of the continental terminal of the township of Abomey-Calavi are compliant to the norms of the WHO and Benin according to which the admissible maximal value of the conductivity of the drinking water is of 2,000 µS/cm.

With to the software SPSS (Statistical Package for Social Science) the coefficient of interrelationships between the physical and chemical parameters of the waters of drilling analyzed was calculated. The TDS is perfectly bound to the conductivity (1.000). For all drilling that we studied, the TDS (in mg/L) measured is equal at 0.56 times the conductivity (in µS/cm) measured.

3.1.5 Temperature

The temperature plays a role in the solubility of salts and especially of gases, in the dissociation of salts dissolved therefore on the electric conductivity, in the determination of the pH, for the knowledge of the origin of water and eventual miscellanies. The temperature of waters is influenced strongly by the environmental conditions bound to the geographical position of the locality, to the geology of the lands crossed, to the hydrology and especially to the climate [7]. The temperature of water is an important factor in the biologic production. It comes because it affects the physical and chemical properties of this one; in particular its density, its viscosity, the solubility of its gases (notably the one of the oxygen) and the chemical and biochemical reaction speed [6]. In the region of survey, the gotten results show that the temperature doesn't present big variations of a drilling to the other (Fig. 7), with a minimum of 23.1°C (drilling F6) and a maximum of 30.6°C (drilling F3).

![Fig. 5. Spatial variation of the pH values](image-url)
3.1.6 Turbidity

The turbidity translates the presence of particles in abeyance in water (organic remnant, clays, microscopic organisms...). A strong turbidity can allow microorganisms to set on particles in abeyance. When the turbidity is lower in 5 FNU, water is lucid. When it is understood between 5 and 30 FNU, water is slightly troubled and when the turbidity is superior to 50 FNU, water is troubled [3]. When the turbidity is raised, water is colored. According to the norms of Benin of February 20th, 2011, the turbidity of a water destined to the consumption must be lower or equal in 5 FNU. In the region of survey, the gotten results show that the present turbidity of big variations of a drilling to the other (Fig. 8), with a minimum of 0 FNU (drilling F₄, F₁₀, F₁₄, F₁₉, F₂₂, F₂₃, F₂₆, F₂₉, F₃₂, F₅₂, F₆₈ and F₆₉) and a maximum of 64 FNU (drilling F₃₈). 50.64% of waters analyzed have a turbidity compliant to the norms of Benin.

3.1.7 Calcium

It is a major component of the water hardness. The calcium is generally the dominant element of
the drinking waters [7]. The maximal value of the calcium in a drinking water according to the WHO is of 400 mg/L. In the region of survey, the gotten results show that the concentration in calcium presents big variations of a boring to the other (Fig. 9), with a minimum of 1.2 mg/L (drilling F8) and a maximum of 81.76 mg/L (drilling F3).

3.1.8 Magnesium (Mg2+)

Magnesium constitutes a major element in the hardness of water and its content depends on the sedimentary rock composition [7]. The maximal value of magnesium in a drinking water according to the WHO is of 50 mg/L. In the region of survey, the gotten results show that the concentration in magnesium varies from a drilling to the other (Fig. 10), with a minimum of 0 mg/L (drilling F68 and F76) and a maximum of 54.96 mg/L (drilling F39). Only the water of the F39 drilling has a concentration in magnesium superior to the admissible maximal value of the WHO for a drinking water.
3.1.9 Iron (Fe^{2+3+})

The presence of iron in the underground waters has multiple origins: Iron, under shape of pyrites (FeS$_2$), is associated fluently to the rock sedimentary put down in reducing environment (marls, clays) and to the metamorphic rocks. It often meets to strong concentrations in the waters of the breastplates of pedestal change. Present, under reduced shape (Fe$^{2+}$), iron is oxidized by the oxygen of air and hurl down under ferric shape when water is pumped. Iron is soluble to the state of Fe$^{2+}$ ion (ferrous ion) but insoluble in the Fe$^{3+}$ state (ferric ion). The value of the potential of oxidation-reduction of the middle conditions its solubility and the content of water made of iron therefore. The captive water table isolated of the exchanges with the surface are in reducing conditions: their water is ferruginous. This dissolved iron hurls down in middle oxidizing, in particular to the level of the sources and to the exit of the conducts. The presence of iron in water can encourage the proliferation of some stumps of bacteria that hurl down the iron where corrodes the pipelines. The maximal value of total iron in a drinking water according to the WHO is of 0.2mg/L. The contents made of total iron in the region of survey vary 0mg/l (drilling F$_{1}$, F$_{5}$, F$_{9}$, F$_{10}$, F$_{16}$, F$_{17}$, F$_{22}$, F$_{24}$, F$_{25}$, F$_{31}$, F$_{33}$, F$_{34}$, F$_{36}$, F$_{56}$, F$_{63}$ and F$_{74}$) and a maximum of 3.5798mg/L (F$_{39}$ drilling). 98.7% of the studied drilling waters have a concentration made of total iron compliant to the norms of the WHO for a drinking water.

3.1.10 Ions Ammonium: (NH$_4^+$)

Ions ammonium constitutes the first element in the mineralization of the organic matter in nitrates. The maximal value of ammonium in a drinking water according to the WHO is of 0.5mg/L. In the region of survey, the gotten results show that the concentration in ammonium varies appreciably from a drilling to the other (Fig. 12), with a minimum of 0mg/L (drilling F$_{1}$, F$_{4}$, F$_{8}$, F$_{9}$, F$_{10}$, F$_{16}$, F$_{17}$, F$_{22}$, F$_{24}$, F$_{25}$, F$_{31}$, F$_{33}$, F$_{34}$, F$_{36}$, F$_{56}$, F$_{63}$ and F$_{74}$) and a maximum of 3.5798mg/L (F$_{39}$ drilling). 98.7% of the studied drilling waters have a concentration in ammonium compliant to the norms of the WHO for a drinking water.

3.1.11 Bicarbonate: (HCO$_3^-$)

This element, for which no value of reference is defined, is present in all waters to considerable contents. Their meaningful presence in the wells and relatively important in the drilling is a characteristic of the underground waters of the regions of the pedestal of Africa [5,8,9]. In the region of survey, the gotten results show sensitive variations of a drilling to the other (Fig. 13), with a minimum of 0.1 mg/L (drilling F$_{22}$) and a maximum of 308.05 mg/L (drilling F$_{72}$).

![Fig. 10. Spatial variation of the concentration in magnesium](image-url)
3.1.12 Chloride: (Cl$^-$)

The origin of the ions chlorides in the underground waters can be bound to the geological formations. They can be also of organic origin. The nitrogenous pollution of organic origin is often accompanied by a pollution by the ions chlorides. The abundance of the ions chlorides in waters can be due to the activity natural of the plant table setting [10]. The maximal value of the ions chlorides in a drinking water according to the WHO is of 250 mg/L. In the region of survey, the gotten results show that the contents of waters analyzed vary slightly for 76 boring (Fig. 14), with a minimum of 6.65 mg/L (drilling F$_{29}$) and a maximum of 35.5 mg/L (drilling F$_{43}$). The content in chloride of the waters of the drilling F$_{40}$ (1,224.8 mg/L) is extensively superior to the one of the other drilling. The waters of the drilling F$_{40}$ are the only drilling of the survey zone of which the concentration in ions chloride is not compliant to the norms of the WHO for a drinking water.
3.1.13 Nitrite: (NO$_2^-$)

The nitrites form themselves from a reduction of the nitrates or from an incomplete oxidization of ammonium [11]. The underground water contamination by the nitrates can be caused by the spreaing of manure, of chemical manures, or the domestic strong garbage or by the septic facilities. These products free the nitrates that infiltrate in this one with reactions of decomposition in nitrites to the contact of soil. These nitrites, evolve to reach the tablecloths of underground water. The strong contents correspond to the reduction of the nitrates in nitrites by the anaerobic sulfito-reducing. They can also be bound to the bacterial oxidization of ammonia [12]. The maximal value of nitrite in a drinking water according to the WHO is of 0.1 mg/L. In the region of survey, the gotten results show that the concentration in nitrite varies appreciably from a drilling to the other (Fig. 15), with a minimum of 0.01 mg/L (drilling F$_53$) and a maximum of 3 mg/L (drilling F$_30$). All studied drilling waters have a concentration in phosphate compliant to the norms of the WHO for a drinking water.

3.1.14 Phosphate

The maximal value of phosphate in a drinking water according to the WHO is of 5 mg/L. In the region of survey, the gotten results show that the concentration in phosphate varies appreciably from a drilling to the other (Fig. 16), with a minimum of 0.0891 mg/L (drilling F$_6$). All studied drilling waters have a concentration in phosphate compliant to the norms of the WHO for a drinking water.

3.1.15 Ions Fluorides: (F$^-$)

The main sources of fluorine in the underground waters are the sedimentary rocks but also the rocks magmatic and some veins. The zones of water cures are also concerned. Fluorine in moderate concentration can have beneficial effects for health in terms of prevention of the tooth decay. When the distributed waters in contain less 0.5 mg/L, the use of salt fluorinated is recommended. A defaulting or an excess in fluorine provoke some inconveniences whereas some moderate doses are beneficial for health. Fluorides ingested with water are nearly absorbed in totality and distribute themselves quickly in the organism (essentially the skeleton and the teeth).

The margins between useful and poisonous doses sum up as follows:

- Less 0.5 mg/L: Deficiency in fluorine to warn the tooth decays,
- Enters 0.5 and 1.5 mg/L: Optimal dose to warn the carries,
- Enters 1.5 and 4 mg/L: Risk of bony fluorosis (bony and articular pains accompanied by distortions).

![Fig. 13. Spatial variation of the values of carbonates](image-url)
Of made it of the fixing of the ion calcium by ion fluorine, this last driven a hypocalcaemia. To very strong dose (a few hundreds of mg), ion fluoride can provoke the pathological states, as gastroenteritis hemorrhagic, nephrite sharp and various illnesses of the liver and the muscle cardiac. Somme vomits, abdominal pains, nauses, diarrheas or even convulsions are the first symptoms of the poisoning [13]. The maximal value of ions fluorides in a drinking water according to the Beninese legislation is of 1,5mg/L. In the region of survey, the gotten results show that the concentration in ions fluoride varies appreciably from a drilling to the other (Fig. 17), with a minimum of 0mg/L (drilling F5, F10, F12, F13, F14, F19, F20, F22, F23, F28, F29, F32, F34, F37, F38, F45, F47, F50, F52, F59, F60, F61, F64, F68, F69 and F74) and a maximum of 0,74mg/L (drilling F16). All studied drilling waters have a concentration in fluoride compliant to the norms of Benin for a drinking water.

All the samples have values of conductivity and contents in calcium, in sulphate, in nitrite and in phosphate conform to the norms of the WHO. The values of the turbidity and the hardness and the content in fluoride are respectively compliant to the norms of Benin in 50.64%; 97.40% and
100% of the samples analyzed. The values of the pH, of magnesium, of iron, the chlorides, the nitrates and ammonium are respectively compliant to the norms of the WHO in 7.2%; 98.7%; 79.22%; 98.70%; 98.70% and 97.4% of the samples.

3.1.16 Bacteriological Quality of water

We appreciated the bacteriological quality of the ground water of the continental terminal of the township of Abomey-Calavi through the measure of three parameters: total coliforms, coliforms thermotolerants and the intestinal enterococci. The picture returns the middle concentrations of these microbial germs below for every precinct of the township of Abomey-Calavi.

The groups of coliforms understands the bacteria belonging to the family of the Enterobacteriaceae and makes to two entities appear: one is mainly the one of the coliforms of fecal origin or coliforms thermotolerants hosts of the digestive tube of the man and of the animals warm-blooded; the other of non-fecal origin, is part of the aquatic bacterial communities (comes of the infiltration waters) or telluric (comes of the earth).

A gram of excreted includes a million to one billion of coliforms thermotolerants. The species the more frequently associated to this bacterial group is the *Escherichia coli* and in a least measure, some species of the Citrobacter kind, Enterrobacters and Klebsiellas [13,14,3]. The bacterium *Escherichia coli* represents all time 80 to 90% of the coliforms thermotolerants detected (Edberg and al, 2000). The interest of the detection of the coliforms thermotolerants, as indicatory organisms of fecal pollution, resides in the fact that their survival in the environment is generally equivalent to the one of the pathogenic bacteria and that their density is generally proportional to the degree of pollution produced by the fecal matters [15].

A gram of excreted includes hundred one thousand to 100 million intestinal enterococci. These are bacteria of rounded shape and of which the individuals, regroup in chain. They are of fecal origin or no (plants, bugs, soils). They can be a pathogenic bacterium indicator (because of their inability to increase in the aquatic environment) and of virus because of their strong resistance (surviving longer in aquatic environment that the coliforms thermotolerants) [1].

With regard to the total coliforms, the middle concentration is the order of 12.33/100 ml. The maximal middle concentration is recorded in the precinct of Godomey (25/100 ml). The research of the coliforms thermotolerants by precinct shows that the waters of boring to the level of the survey region contain a middle concentration of the order 4/100 ml. The maximal average in

![Fig. 16. Spatial variation of the values of the phosphates](image-url)
Table 1. The middle microbial germ concentration by precinct to the level of the boring

| Averages of the concentrations to the level of the boring | Total coliforms (100 mL) | Coliforms thermotolerants (100 mL) | Intestinal enterococci (100 mL) |
|----------------------------------------------------------|--------------------------|---------------------------------|---------------------------------|
| Abomey-Calavi                                            | 9                        | 3                               | 2                               |
| Akassato                                                 | 8                        | 2                               | 1                               |
| Glo-Djigbé                                               | 7                        | 1                               | 1                               |
| Godomey                                                  | 25                       | 9                               | 7                               |
| Hevié                                                    | 21                       | 7                               | 5                               |
| Kpannoun                                                 | 8                        | 2                               | 1                               |
| Ouedo                                                    | 12                       | 5                               | 3                               |
| Togba                                                    | 6                        | 1                               | 1                               |
| Zinvié                                                   | 15                       | 6                               | 4                               |

coliforms thermotolerants is recorded in the precinct of Godomey (9/100 ml). As for the intestinal enterococci, we noted that the middle concentration of the boring waters in the region of survey is the order of 2.77/100 ml, with a maximal middle value recorded in the precinct of Godomey (7/100 ml). The watertable of the continental terminal shelters strong densities of total coliforms, coliforms thermotolerants and intestinal enterococci. These results are similar to those found to the level of the water table of the plio-quaternary in the region of Meknès to Morocco [4].

4. CONCLUSION AND RECOMMENDATIONS

The results of the physical and chemical analysis of the water of the continental terminal of the township of Abomey-Calavi are not compliant to the norms of the WHO and Benin in 98.7% of the studied boring. Some very elevated concentrations present bacteriological view point, the studied boring, in germs of fecal contamination in all boring without exception, what probably constitutes a threat for the farming zone inhabitants who consume the water of these boring that they consider like drinkable.

To avoid the possibility of all sanitary risk us recommend:

- Treatment of water on a domestic scale by the use of the swath water with the help of an account drops,
- Extension of the network of the drinking water of the National Society of the waters of Benin (SONEB) in farming environment,
- Conception of the purification network for the worn-out water evacuation,
- Pickup of garbage,
- Protection of the catchments.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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