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HEALTH RISKS OF THE QUALITY OF THE WATER USED BY THE OPERATORS OF THE HOUEYIHO MARKET GARDEN SITE (COTONOU) IN BENIN

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ABSTRACT

The market gardening is an activity that develops more and more through Benin. In the municipaty of Cotonou, there are several gardening's perimeters of which the most important ant the oldest is at Houéyiho where this activity is practiced since more of 40 years. On this site the quality of water used for the watering is not always clean. That justifies the choice of our training at the end of my formation. To achieve this objective the participating observations and semi-structured interviews guide were conducted with 20 market gardeners of the cooperative DON DE DIEU. This cooperative is situated in the North zone of the site and regroups 36 men and 4 women market gardeners. Water samples have been analyzed during two periods of measure (humid season and dry season) for the determination of the physical and chemical and bacteriological parameters. The results of these analyses show a contamination of water. The elevated values are observed to the level of the calcium (136,136 mg/l), of the chloride (514,75 mg/l), of ammonium (1,819 mg/l), of the total iron (1,98 mg/l), of fluoride (1,61 mg/l), of the nitrate (119,61 mg/l) and by pathogenic germs as the total coliforms (842 unites/ml), the fecal coliforms (414 unites/ml) and the fecal streptococci (289 unites/ml). This toxicity of water is due to the Hydro geographicallocation of the site and the ecological characteristics of the city of Cotonouand to the agricultural input contributions for fertilizing the soil. It causes parasitic, respiratory, digestive, hematological, enzymatic unrests, dermatologiques and others diseases at the market gardeners because of their contacts with water and for the consumers of these vegetables.

Keywords: Market gardening, Water of irrigation, Physical and Chemical, Bacteriological, Toxicity.

1. INTRODUCTION

The growth of the world population is arguably one of the greatest threats today in the face of poor food availability. Although significant efforts are being made to fight against food insecurity, it remains a source of concern and concern throughout the world, especially in developing countries where populations have increased significantly over the past 20 years, particularly in the cities.

In Benin, the population passed the ten million mark in 2013 (INSAE, 2013) with an increase of approximately + 2.7% and an urbanization rate estimated at 44.64%. This strong demographic growth leads to an increase in food needs in cities (Agueh et al., 2015).

Market gardening therefore appears to be an essential recourse to the supply of foodstuffs for city dwellers, in particular fresh vegetables, and this in a permanent and sustainable manner to ensure food security. Studies carried out by Mbaye and Renson (1997) have shown that the supply of market garden products in Benin in general and in the main cities in particular is well below demand. The observation is that Benin continues to import a good part of market garden products for consumption from countries of the sub-region such as Burkina Faso, Nigeria, Ghana, Niger etc., despite the favorable agro-climatic conditions for the practice of these crops (Tiamiyou and Sodjinou, 2003) .This trend has strongly encouraged the national agricultural development bodies, which have initiated a program to promote the market gardening sector to, among other things, enhance the many lowlands , swamps, valleys and flood plains which abound in the wetlands of southern Benin and, by extension, organize young people into cooperatives to reduce unemployment and poverty. For this, market gardening has been identified and retained as one of the priority agricultural sectors to be promoted, which has given rise to several projects which are designed to support market gardeners and help them professionalize in their activities.

Market gardening in Cotonou appears more and more as an essential activity, generating income and which also contributes to the sanitation of the city through the recovery of household waste. The composting experiment undertaken by the Household Solid Waste Management Project (PGDSM)) at the Houéyiho market gardening center is a good illustration of this. Garbage is collected, sorted and then made available to market gardeners who should make compost (YèhouenouPazouet al., 2010). As the market gardening activity is very difficult, market gardeners use untreated household waste, poultry droppings, faeces from pigs reared on site and unsuitable pesticides especially those intended for cotton processing. All these inputs do not guarantee the quality of the vegetables produced (Assogba-Komlan et al., 2007) and also the well-being of market gardeners.

Water, which is an essential factor in vegetable production, presents problems related to its quality. In fact, the irrational use of these synthetic products leads to the accumulation of micropollutants in the soil, in water or even in plants, thus leading to intoxication of producers as well as consumers. Thus, the use of infected water to meet the water demand of different vegetable crops affects the quality of the products harvested. The consumption of such products could constitute a source of diseases such as cholera, hepatitis, dysentery, typhoid fever, amebiasis, hyper eosinophilia, thrombocytopenia. For this purpose, analyzes to determine the current state of the physico-chemical and bacteriological quality of the irrigation water at the Houéyiho market gardening site are essential. It is with this in mind that the present study was initiated on this Houéyiho site in the heart of Cotonou, the economic capital of Benin, in order to analyze the quality of the irrigation water used by market gardeners and the related health risks.

2. ECOLOGICAL CHARACTERISTICS OF THE STUDY ENVIRONMENT

2.1 Geographical characteristics of the site

The study site is located on the coastal barrier wedged between the waters of Lake Nokoué to the north and the Atlantic Ocean to the south. The geomorphology of the site consists of alluvial sand banks of about five meters in height. On the right bank of the channel that separates the two parts of the city, is the Dantokpa International Market which leads to wild dumps of waste of all kinds along the banks, which are dumped into the lagoon or leached directly into the water table. shallower throughout the city.

The environment is marked by a subequatorial climate with an alternation of two rainy seasons (April to July and October to November) and two dry seasons (December to March and August) .The rainfall varies between 900 and 1200 mm, while the average temperature is around 27 ° C. Remarkable heat is observed during the months of February to April while those from July to September are the coolest (Agbossou et al., 2003). The most remarkable wind in the Municipality comes from the ocean but there is also, the harmattan, this dry wind which generally occurs during November to December.

During the great rainy season, the city is threatened by serious flooding, because the low level of the relief is strongly influenced by the variations in the heights of the water bodies and the ocean. It is also threatened by coastal erosion which takes place at an average rate of 16.8 meters per year, especially on the east side (Akomagni et al., 2006).

From a pedological point of view, the Municipality has sandy soils which are generally poor with low exchange capacity and low water retention capacity. The soils are hydromorphic, leached with a podzolic tendency, permeable and not very fertile. These soils are transformed by a permanent supply of organic matter in order to practice market gardening all year round.

The water table is located near the surface of the soil, whose high permeability accelerates water infiltration, which directly influences the water table and generates pollution risks (Akomagni et al., 2006). Fluctuations in water levels the ocean and lagoons with the rain, are related not only to the hydrodynamics of the water table but causes a salinity of the fresh water of the continent (Agbossou et al., 2003).

The characteristic vegetation of these environments is the mangrove, which supports the high ambient salinity. The dominant plant species are those from swampy and saline ecosystems such as red mangrove (*Rhizophora racemosa*), white mangrove (*Avicennia africana*) and mangrove fern (*Acritichu maurem*). Other aquatic species like Typha australis are found in the city's wetter areas.

Economically, the city of Cotonou is the country's main hub of economic activity. Commercial activities are carried out in large markets such as that of Dantokpa. An industrial zone is developing in the south-east of the city and is the seat of waste which is not always treated or well managed before being discharged into the immediate environment. The most prominent crop production is intensive market gardening which is carried out on eight (08) large sites in the heart of the city, including that of Houéyiho, which houses the present study. This site located in the area of the airport is developed over 15 ha with a workforce of 334 producers, including 54 women.

In terms of water, two types of water sources are used on the site, namely boreholes by collecting underground water from a depth of 6 to 7 m which is done using a hydraulic machine (pump) and water from the swamps of the inside the site where the water is flush with the ground or visible in small well-shaped holes There are also cement basins built on the site which are intended for the storage of borehole water according to the irrigation techniques adopted by the operators .

2.2 The water sources of the various irrigation systems installed on the site

Two irrigation techniques are used to bring water to crops: A good knowledge of plants and their interactions with the soil, water / atmosphere relationships are essential to ensure good irrigation. Good irrigation should help save water by providing the plant with the exact amount of water it needs for its development without compromising its quality. The water sources used for irrigation include water from boreholes, wells, ponds and swamps which occupy 3 ha of the 15 ha of the site. The water supply or the irrigation of the crops is done by the pumps which make it possible to suck the water and to push it back in the distribution pipes then to the crops by sprinkling, micro-sprinkling or by means of watering cans. water is also pumped into the basins which constitute reservoirs before watering.

3. MATERIAL AND METHODS

In order to better understand the subject, various approaches have been adopted: collection of data by documentation and by field survey, analysis of water samples in the laboratory and processing of the results.

3.1 Data collection

It is based on both a qualitative and quantitative approach to the problems of water quality used for irrigation through documentary research and direct observations in the field by participating in the various activities carried out on the site.

A census of market gardeners and workers working on the site found that several market gardeners cooperatives exist there, but our interviews were conducted with a 50% sample of forty (40) workers from a randomly selected five cooperatives. Within this cooperative, the respondents were chosen according to a step of 1 out of 2 from their attendance list. The purpose of these interviews was to deepen the description of the site, its management, the progress of the various activities, and take an inventory of the problems and threats encountered by market gardeners through the use of water using a maintenance guide.

3.2 Sample collection and laboratory analysis

3.2.1 Sampling method

Samples for the measurement of physicochemical and bacteriological parameters were carried out respectively in 1.5 liter plastic bottles and in sterilized 1 liter jars for the two types of water sources on the site (groundwater and surface water Before each water intake, the jars were sufficiently rinsed with water from the source. The swamp water samples were taken at a depth of 30 cm from the surface, on the other hand at the level of the borehole water, the sample is taken at the turnstiles during watering. For bacteriological parameters, the sample is taken in vials sterilized then stored in a cooler containing ice packs to maintain bacteriological integrity during transport to the laboratory.

The procedure was the same for each of the two campaigns and the analysis results were compared with the quality standards of drinking water intended for human consumption, with the quality standards of wastewater in the Republic of Benin (Ministry of Santé, 2001) in application of the provisions of the framework law on the environment in Benin and the directives of the FAO.

Eighteen (18) physicochemical parameters and three (3) bacteriological parameters were measured to assess the quality of these waters.

3.2.2 Physico-chemical analysis of water samples

The physico-chemical parameters best express the risks associated with water quality and can be summarized as follows: pH, temperature, electrical conductivity, alkalinity, water hardness, calcium, magnesium, bicarbonates, chlorides, fluorides, color, ammonium, iodine, nitrates and nitrites, phosphate, sulphate and total iron for the physico-chemicals (Belghiti, 2013; Rodier et al. (2009).

3.2.3 Bacteriological analysis of the water

As for the bacteriology of water, it is based on research for bacteria considered to be indicators of faecal contamination, namely total coliforms, faecal coliforms and faecal streptococci.

Bacteriological analyzes were based on the method of binding to membranes capable of retaining bacteria. Petri dishes were introduced into an incubator at a temperature of 44.5 ° C. for 24 hours and the count was made on the membrane as a function of the colorations of the different colonies of bacteria.

3.3. Data processing

To ensure the quality of the data obtained, several sources of information with different data collection tools were used. The water quality analysis results and questionnaire data were processed manually and are integrated into suitable processing software such as Excel and R Software.

4. RESULTS

4.1. Physico-chemical characteristics of the water at the Houéyiho site

The most important results of the physico-chemical analyzes of irrigation water likely to pose risks to human health are presented and discussed in this section.

- **pH values**

The pH of the water sampled varies from 6.15 to 6.27 and is not within the range of standards provided for or recommended by Decree No. 2001-094 of April 4, 2001 setting the quality standards of drinking water in the Republic of Benin. ($6.5 < ph < 8.5$) Due to their pH values, these waters are therefore acidic and are not recommended for drinking or consumption. In addition, the waters of the swamp have the highest pH. According to Rodier et al. (2009), the alkalinity of water, also called the alkalinity, characterizes the ability of water to maintain its pH constant. The average alkalinity of the water sampled is 30 mg / l for the two seasons and the values remain constant in the two types of water sources during the two measurement campaigns.

- **The temperature**

The temperature of the water is important to know because it plays a determining role in the modification of the physical and chemical properties of the water. In fact, it influences the biological reactions that occur in water (Makhoukh, 2011; Akil et al., 2014). Indeed, at high temperature, water develops microorganisms, thus promoting taste problems. , color and odor (WHO, 2011).

The values of the temperature of the sampled water vary between 25.5 ° C and 27.5 during the two campaigns whatever the source, with the highest values at the level of the borehole. The two parameters (pH and temperature) have less direct effect on water quality.

- **Electrical conductivity**

The highest conductivity values measured at 25 ° C on the site water during the two measurement campaigns are around 1400 µs / cm, higher than the maximum value recommended by the WHO standards (1200 µs / cm) but lower than that of the Republic of Benin is 2000µs / cm (Figure 1).

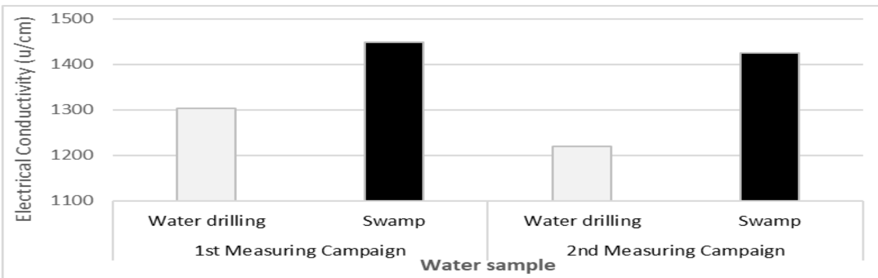

Figure 1: Evolution of the conductivity of the water sampled on the site

- **The hardness of the water**

The hardness of the water (or Hydrotimetric Title) is generally an indicator of the mineralization which influences the toxicity of the water (Atidégla and Agbossou, 2010). It is a function of the concentrations of Calcium and Magnesium.

Calcium is an essential nutrient for plants. It participates in the constitution of the cell walls of plants by stiffening them. Too much calcium leads to deficiencies in magnesium and potassium. However, at very high concentrations it can have negative effects on the absorption of other essential minerals.

The magnesium content of the sampled water varies from 23.35 to 33.56 mg / l and complies with the FAO standards (FAO, 1985) which is 50 mg / l for irrigation water. But for the hardness of the water sampled, it varies between 324 and 450 mg / l and remains below the standards recommended by the FAO (500 mg / l) for agricultural use (figure 2). But hard water can cause scaling problems in pipes and distribution or irrigation devices. These are the reasons why the concentrations in drinking water must not exceed 50 mg / l for magnesium and 100 mg / l for calcium.

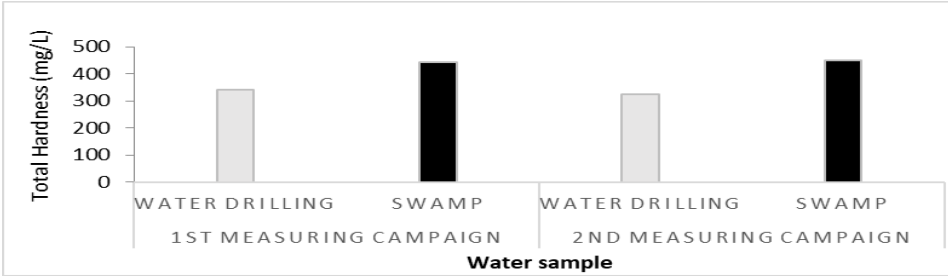

Figure 2: Evolution of the total hardness of the water

The values of the hardness of the swamp water, whether in the 1st or 2nd measurement campaign, are higher than the borehole water (Figure 3).

The calcium contents are closely linked to the nature of the terrain crossed. For magnesium, the magnesium hardness is higher in the drilling water of the second measurement campaign, therefore in less humid periods.

- **Total iron content Total iron (Fe2 + / 3 +)**

Iron, although it is not a constituent of chlorophyll, it is essential for its formation. It participates in the constitution of many oxidizing enzymes. It is taken up by the roots as a ferrous Fe2 + ion.

In the results, the total iron values vary between 0.32 and 1.98 mg / l (figure 3).

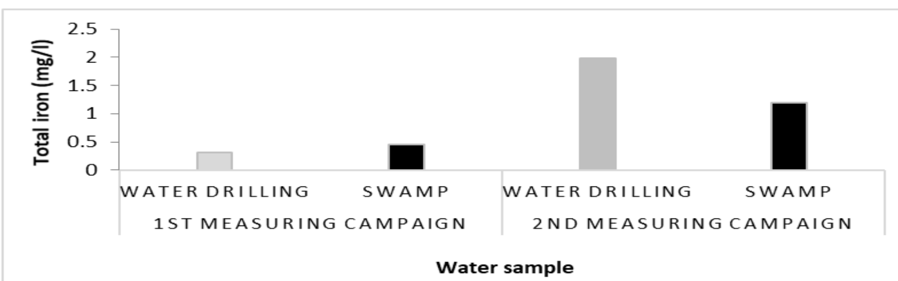

Figure 3: Evolution of the total iron content of the water

The figure shows that the highest levels are observed during the second measurement campaign and are 1.2 and 1.98 mg / l which exceeds the recommendations of the Beninese directive and the FAO (0.3 mg / l). It should then be noted that the content varied according to the periods, that is to say between the wet period and the dry period.

Iron levels between 1 and 2 mg / L are considered optimal for the nutrition of the plant while in contrast, levels above 0.1 mg / L of ferrous iron (Fe2 +) can cause obstruction of irrigation emitters. Its deficiency in the plant causes interveinal chlorosis which affects the youngest leaves on the plants.

- **Ammonium (NH4+)**

The ammonium ion (NH_4^+) is a troublesome element in drinking water because it interferes with chlorination to form chloramines which modify the smell and taste of the water. Its presence in the soil, then in irrigation water, is therefore strongly linked to the amount of organic matter used by market gardeners to amend beds and to the environmental conditions.

The ammonium content of the water sampled varies from 0.735 to 1.819 mg / l and exceeds the water quality standard (0.5 mg / l). Depending on the physicochemical characteristics of the soil and water, this can lead either to nitrogen enrichment or to acidification with the disappearance of fauna and flora in extreme cases.

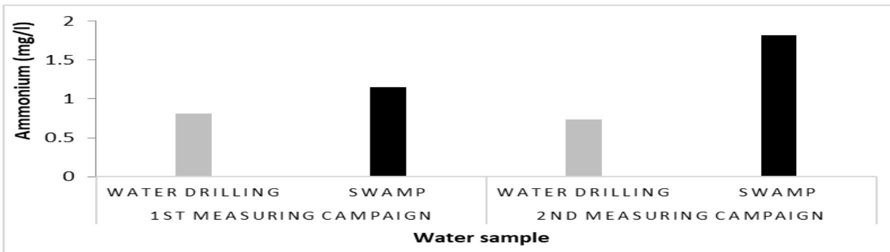

Figure 4: Evolution of Ammonium in the sampled water

Through this figure, it can be seen that all the samples have Ammonium contents higher than the standard (0.5 mg / L).

With regard to vegetable crops, ammonium in itself is toxic, on plants, this leads to an imbalance in their diet and increases their sensitivity to other secondary stressors. But this substance is not really dangerous for human health.

- **Nitrates and nitrites content**

Nitrates are one of the main sources of nitrogen for plant growth and come from the decomposition of organic waste. Under the oxidative action of microorganisms, nitrates (NO_3^-) are formed naturally from the ammonium ion (NH_4^+). As for nitrites (NO_2^-), they are formed by degradation of nitrogenous matter but are quickly transformed into nitrates in drinking water sources (Levallois and Phaneuf, 1992). They are naturally present in vegetables and water. On the site, the nitrite contents of the water analyzed range from 0.05 mg / L to 18.7 mg / Let do not exceed the standards of the WHO (WHO, 2000), nor of Benin, which are 3.2 mg / lL. On the other hand, the nitrate concentrations are higher than the standards set at 50 mg / L for drinking water, with the exception of drilling water in the second campaign, the content of which is 9.37 mg / L (figure 5).

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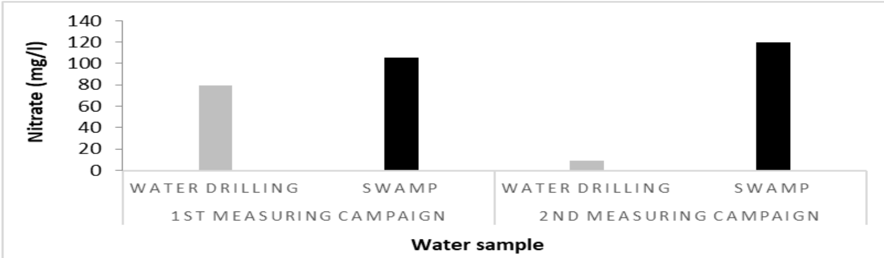

Figure 5: Evolution of the nitrate content of the water at the Houéyiho site

These high levels of nitrates can be explained by the presence of human activities. Indeed, the sustained use of chemical or organic fertilizers in plant production, septic tanks, animal manure and effluents (municipal and industrial) are the main sources of water contamination by nitrates (Levallois and Phaneuf, 1992; WHO, 2011; Akil et al., 2014 cited by Orelien et al., 2016-2017).

- **Sulfate (SO_4^{2-}) and Phosphate (PO_4^{3-})**

Sulphates are involved in the architecture of complex proteins found, for example, in wheat grains (gliadins, glutenins). It gives a bitter, medical taste to water if it exceeds the concentration of 250 mg / L. The sulphate contents at the site are shown in Figure 6.

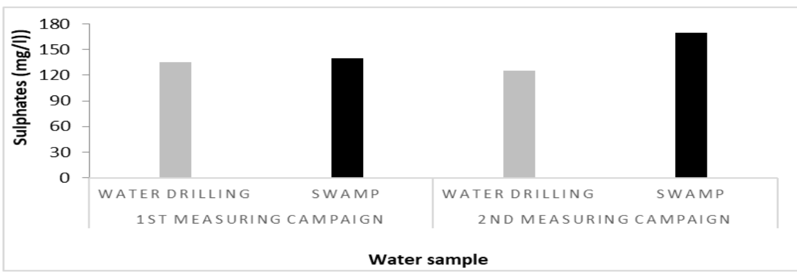

Figure 6: Evolution of sulphates in water samples

The highest value of sulphate observed is in the swamp water sampled during the 2nd measurement campaign (170 mg / l). Its presence is explained by the use of synthetic or natural fertilizers on the site by market gardeners.

It can also affect the protein content and composition of cereals or other crops.

But non-toxic in themselves for animal and plant life, they harm the environment as soon as they are in high concentrations: they then become real fertilizers for aquatic environments which they enrich with organic matter (Ballouki, 1992).

The values of (**PO_4^{3-}**) obtained for borehole and swamp water (0.45 and 0.82 mg / l) are below the water quality standards of Benin (5 mg / l) and are not endangered neither for plants nor for humans.

Chloride (Cl^-) contents

Usually in the form of sodium (NaCl) and potassium (KCl) salts. Chlorides are often used as an index of pollution; they have an influence on aquatic flora and fauna as well as on plant growth.

The water sampled has a chloride level that varies from 301.75 to 514.75 mg / Let are therefore above the recommended standards of Benin limited to at most 250 mg / L (figure 7). Crop roots easily absorb chlorine in the form of the Cl- anion and this is very mobile in the plant.

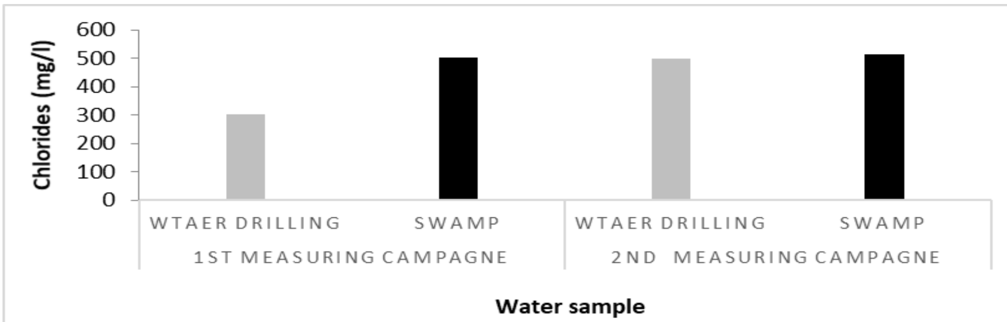

Figure 7: Evolution of chlorides in the sampled water

The chloride contents of the site's water sources are higher than the maximum admissible value recommended by the standards in Benin, which is 250 mg / L. Chlorine is necessary for photosynthesis. Chlorine toxicity thresholds are very variable: chlorophobic plants such as berries, citrus fruits and certain vegetables are sensitive to an excess of chlorine unlike chlorophyll plants (beet, cabbage, carrot).

Fluorides (F^-)

Fluorides are mineral salts that can occur naturally in soil. Its excess can cause inconvenience, especially in the area of human teeth.

The fluoride values obtained in the samples are low but significant compared to the recommended standards (1.5 mg / L) (Figure 8).

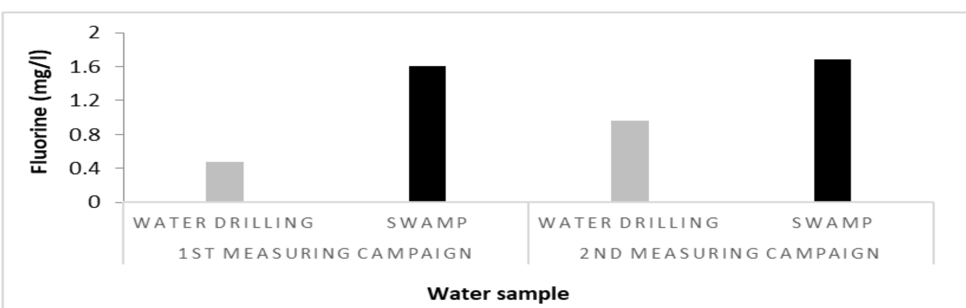

Figure 8: Evolution of fluorine in sampled water

Through the figure, we see that the fluoride contents in the boreholes are low compared to the swamps where the values approach the norm through the two campaigns.

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4.2. Bacteriological pollution

Bacteriological analysis of the irrigation water from the Houéyiho market garden site revealed the presence of total coliforms, faecal coliforms and faecal streptococci in all the samples analyzed, which illustrates a source of faecal contamination. Figure 9 shows the values of each bacteriological pollutant over the two campaigns.

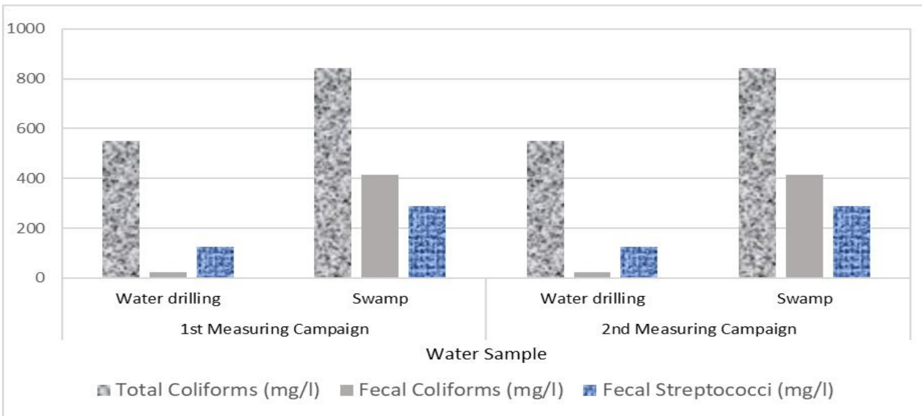

Figure 9: Evolution of Total Coliforms, Fecal Coliforms and Fecal Streptococci

The values observed through Figure 10 vary from 386 to 842 per mL for total coliforms, 18 to 414 per mL for fecal coliforms, and 98 to 289 per mL for fecal streptococci. However, the standards recommended for drinking water in Benin for these germs are: 0 CFU for fecal coliforms, 10 CFU for total coliforms and 0 CFU for faecal streptococci per 100 mL sample, taking into account the high levels of these germs in water, the agricultural use of raw water from the Houéyiho market gardening perimeter should be prohibited because of its strong pollution which could infect vegetables and subsequently contaminate consumers, especially for foodstuffs that are eaten raw such as lettuce, carrots, tomatoes and onions, etc. These vegetables, eaten raw, could constitute a source of water-borne illnesses for market gardeners and consumers.

5. DISCUSSION

The physico-chemical and bacteriological analysis of the irrigation water suggests contamination of these waters at the Houeyiho site. The chloride, nitrate, nitrite and ammonium contents are high both in the borehole and in the swamp and this could be explained by the geological and pedological nature of the rocks crossed. Indeed, the soil being very porous, this leads to a rapid and frank circulation between the different soil horizons of the site which means that these waters are very mineralized. Thus, very sandy soils and poor in organic matter require high inputs such as Pazou Yèhouenou et al. (2010) also mentioned it. But market gardeners use inputs (chemical and organic) that are not recommended on the site, which means that the pollutant values exceed those recommended by the water potability standards in the Republic of Benin.

In general, the pollution of water of agricultural origin is linked to nitrates or phosphates contained in organic or mineral fertilizers and chemical pesticides. However, the use of organic fertilizers, namely composts (animal and human waste, crop residues, etc.) is not often well planned by producers (Lawani et al., 2017). This pollution is due to the leaching of soluble elements, either towards the water table, or towards the watercourses by runoff. So, the use of this water can cause problems on the plant, on the health of market gardeners and consumers, and on the irrigation system: clogging of the system, progressive obstruction of the watering emitters, maintenance cost. high, root blight, plant toxicity, permeability and infiltration problem and plant wilt.

Moreover, several researchers such as Agbossou et al. (2003), Agueh et al. (2015), Yèhouenou Pazou et al. (2010) have shown that the contamination of these vegetable crops is closely linked to the pollution of irrigation water and soil.

According to Agbossou et al. (2003), irrigation water from the Houéyiho market gardening perimeter cannot be used for market gardening because it should be prohibited because of its quality. Indeed, in addition to the constraints of the geographical framework, the poor Mineral and organic fertilization practices of crops affect the bacteriological and physico-chemical quality of surface water through high concentrations of pollutants. Market gardeners use large amounts of mineral fertilizers and chemical pesticides to improve or maintain yields. Likewise, the cleaning of spraying equipment in certain water points is also a risk factor for this resource (Devez, 2004). In addition, the technical itineraries of soil preparation mean that the physico-chemical and biological balances of the soils are often not achieved because the disproportion of nutrients in the new soils induce a proliferation of bacteria and various crop deficiencies (Yèhouenou Pazou et al., 2010).

Bacteriologically, these two water sources at the site contain very large amounts of coliforms and faecal streptococci which indicate faecal contamination (Hounsou et al., 2010). Although the presence of total coliforms in these waters does not generally indicate faecal contamination, but rather a degradation of the bacterial quality of the water. The clinical and biological investigation carried out by Yèhouenou Pazou et al. (2010) with market gardeners in Houéyiho had already highlighted several pathological disorders of higher frequency in market gardeners than in workers or even traders: digestive disorders, parasitic disorders, respiratory disorders, dermatological disorders, haematological disorders and others.

Today, two types of skin lesions are also observed in market gardeners in Houéyiho. These are, on the one hand, plantar keratoderma and, on the other, cases of eczema-like dermatitis. These lesions are due, according to our observations and our analysis, to the conjunction of three actions: on the one hand there is the fact that market gardeners almost always walk with bare feet in the water (permanent humidity) and on the other hand the action of chemicals which infiltrate the ground and release the water of the swamps acidic or basic according to the case and finally the non wearing of boots or the wearing of torn boots then promotes the extension of the lesions. These lesions reach more dangerous stages with age at the site. For example, at stage 3 of the risks, we observe generalized lesions in an elderly market gardener (with a seniority = 10 years). They are most often found on the limbs and mainly on the lower limbs of these market gardeners. These are chronic superinfected eczematiform dermatitis which manifests as rashes of the skin: redness, blisters, ulcers, cracks, bare skin or hives.

Unfortunately, in the absence of well-founded health education and locally adapted interventions, market gardeners do not pay particular attention to the prevention of health risks on their site as noted by Wognin et al. (2013). These results also support those of Keraita et al. (2008) who showed, through work carried out in Accra (Ghana), that nearly 80% of the farmers surveyed did not perceive the health risk associated with the use of wastewater for watering vegetables. However, those who are aware of the potential public health risks underestimate them and prioritize the economic benefits.

As a result, the water sources at the Houéyiho market gardening site have significant effects on the health of market gardeners and permanently pose risks that must be avoided. This is explained by the epidemiological situation of market gardeners, which is characterized by a high frequency of digestive disorders dominated by amebiasis, anemia and dermatosis, which certainly has effects not only on the profitability of farmers but also on their farmers. income.

6. CONCLUSION

The results of the analyzes of the physico-chemical and bacteriological parameters of the irrigation water of the Houéyiho market gardening perimeter in southern Benin have shown that the water used on the site is highly mineralized and presents large colonies of germs of fecal origin.

Likewise, ignorance of and non-compliance with guidelines for the dosage of pesticides, the use of cotton pesticides on market garden crops, the lack of use of sanitary protection equipment are among other things bad cultural practices in risks to the environment and to human health observed on the site. These insufficiencies would certainly have risks on the health of consumers, and it will be necessary to continue the investigations on their health to really appreciate the effects of the consumption of these products based on polluted water. Consequently, measures must be taken to raise awareness the populations, to mobilize equipment and financial resources, to define new effective practices and technologies allowing respect for the environment and human health (market gardeners and consumers).

Raising the awareness of the various site stakeholders should be based on hygiene rules and the use of compost. Market gardeners must wear specific clothing for treating crops with chemicals, and define precise periods for carrying out the treatments.

As a result, some suggestions are made for improving the quality of these waters in order to limit the health risks that their use could cause. This mainly concerns the rationalization of the use of pesticides, the establishment of water quality monitoring systems on irrigated areas. In terms of water management, high concentrations of pollutants in gaseous form must be made to volatilize by first putting the water in well-aerated basins before sending it to the irrigation system.

Clearly, according to the standards in the Republic of Benin, the water from these two sources on the site represents a health hazard, especially for drinking, and therefore risks for the consumption of market garden crops (carrots, lettuce) which are sometimes consumed raw. Therefore, for their use in activities, actions must be taken to correct and protect this water in order to limit the health risks incurred by market gardeners and consumers.

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