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Microbiological and toxicological qualities of the water of watering used in urban agriculture in Cotonou (Republic of Benin)

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Abstract

This study has evaluated microbiological and toxicological qualities of water of watering in Cotonou. A pilot site at Glo-Djigbé, the market-gardening sites of Houeyiho, Fidjrosse and Agongbomey were included in the work. The salmonellas, *Escherichia coli* and cadmium were required in water of watering. On the whole, eight water samples of water were analyzed. Water of watering of the pilot site of Glo-Djigbé is not contaminated by *Escherichia coli* compared to those used at the sites of Houeyiho; Fidjrosse; Agongbomey. Cadmium is absent from all the samples. The study has showed that waters of watering used in urban agriculture in Cotonou are not good and could contaminate the culture, what could induce some diseases with populations.

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Introduction

Urban agriculture became throughout the whole world and specifically in the developing countries, one of the activities necessary to ensure the food safety of the townsmen and to get financial resources with the unemployed persons of the cities. Mougeot (2006) reports that between 2015 and 2020, more half of the world population will live in urban or perish-urban zone. The role of urban agriculture is justified fully taking into consideration this demographic explosion on a worldwide scale. Its contribution with the food production on a world level which was at 15 % in 1993 can have exceeded 33 % as from the year 2005 (Mougeot, 2006).

Smit *et al.* (1996) revealed that this activity is practised in at least 90 towns of 31 countries of the Southeast Asia, of the Middle East, of Europe, of Subsaharian Africa, Antilles and North, Center, South America. In addition, 800 million people practice this activity on a worldwide scale (Koc *et al.*, 2000).The problems of urban agriculture and in West Africa were the subject of several publications which show well its importance in cities (Akinbamijo *et al.*, 2002). Urban agriculture is thus socially very significant. The activities of production, transformation and marketing offer employment opportunities for a significant mass of the urban population in situation of chronic unemployment and the rural ones in seasonal migration.

Benin, following the example of many African countries, experienced these last years, a development of urban agriculture. In the town of Cotonou, the market-gardening production and more precisely that of the vegetable-sheets is a reality impossible to circumvent. It contributes to the provisioning of the markets of the city of food products. The modernization and the intensification of the systems of production induce a stronger use of water of watering (Akodogbo, 2005).

Thus, inside the city, the population developed a local strategy of market-gardening production which resulted in the use of water of the marshes to sprinkle the market-gardening products.

Pathogenic micro-organisms pass in the excreta of the people infected to find itself in water of the marshes being used for watering of the cultures (Dougnon *et al.* (a)., 2012). In the same way, some heavy metals as lead and cadmium could contaminate this water, considering that they are not very deep. As shown by the works of Dougnon *et al.* (b), (2012), water of watering used at Cotonou accumulated lead. This could pose medical problems with the fresh vegetable consumers. As often, when lead is present, cadmium is too, this study proposed to evaluate microbiological and toxicological qualities of the water of watering used on the market-gardening sites of Cotonou.

Materials and methods

Presentation of the sites of study

The survey took into account a pilot site at Glo-Djigbé (6° 56 ' Northern latitude and 2°30' Eastern longitude) and market-gardening sites of Houeyiho (6° 21' 20" Northern latitude and 2° 21' 35" Eastern longitude), Fidjrosse (6° 22' Northern latitude and 2° 24' Eastern longitude); Agongbomey (6° 21' Northern latitude and 2° 24' 45" Eastern longitude) (Fig. 1).

Sampling

It has been used among others of the white sachets labeled to collect samples, of the sterile gloves for withdrawals, an icebox for the transportation of samples. For exams to the laboratory, we used surroundings of culture as Rapid *E.coli*, some serological pipettes, drying ovens, some crushers.

On each site, we carried out in two different market-gardeners, some samples of water of watering. The samples of the water of watering were directly taken in sterile sachets at a rate of 0.5 liter. All the samples were transported in a refrigerator towards the laboratory in a one hour interval after the taking away where they were preserved at once at a temperature of 4° C. The microbiological analyses were carried out in the 24 hours following the test

sample selections. The research for cadmium was made by the two weeks.

Fig. 1. Localisation of included sites.

Microbiological analyses

The microbiological analyses were carried out in the Section Hygiene of Water and Food of the National Laboratory of Public Health at Benin. The purpose of the microbiological analyses are to highlight the presence or not of *Escherichia coli* in the samples of water of watering.

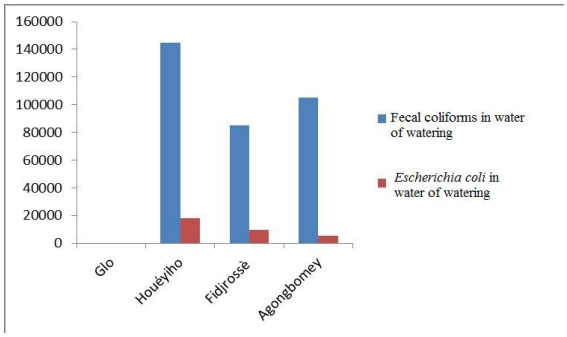

Fig. 2. Presence of fecal coliforms in water of watering.

Research of Escherichia coli

The fecal coliforms and especially *Escherichia coli* were required because they are pilot presence of pathogenic microorganisms. The analyses were made in accordance with the standards of reference NFV 08-053.

Toxicological analyses

They were made at the Laboratory for Sciences Ground, Water and Environment of the National Institute of the Agronomic Research of Benin (INRAB) in Republic of Benin. Cadmium was required in the samples by reading with Atomic Absorption Spectrophotometer (AAS) in accordance with the standards of reference NF ISO 1146 1995 and NF X 31-147 1996.

Statistical analyses

It was calculated the averages and the standard deviations. Multiple comparisons consisting in comparing the averages using the test of Student p (T>t) = 0.05 were made. The softwares used are Microsoft Excel 2010 and XL Stat 2011.

Results

Presence of *Escherichia coli* in the water of watering

Water of watering of the witness site of Glo-Djigbé is not contaminated by fecal coliforms (0 UFC/100ml) whereas those of Houeyiho, Fidjrosse and Agongbomey are it respectively with $14.5.10^4 \pm 70.06$ UFC/100 ml; $8.5.10^4 \pm 106.01$ UFC/100 ml and $1.05.10^5 \pm 70.06$ UFC/100 ml. *Escherichia coli* is absent on the witness site of Glo-Djigbé contrary with Houeyiho ($1.8.10^4 \pm 28.42$ UFC/100 ml), Fidjrosse ($0.95.10^4 \pm 70.10$ UFC/100 ml) and Agongbomey (5545 ± 77.53 UFC/100 ml) (figure 2). These differences prove to be significant because it is about total absence on the site of Glo-Djigbé and presence of coliforms on the other sites ($p< 0.05$).

Contamination of water of watering by cadmium

The averages obtained are consigned in table 1.

Discussion

Presence of fecal coliforms in the water of watering

It was required the fecal coliforms whose *Escherichia coli* in water of watering because these bacteria are produced in the intestine of the animals. When using chicken's droppings to amend cultures, the water can be contaminated. But their presence in vegetables is abnormal and accounts for the sanitary quality of this food. The presence of fecal coliforms brought by our results can be an indication of the presence of micro-organisms like notified by Zmirou *et al.* (1987). Moreover, the presence of *Escherichia coli* confirms the effective presence of the fecal coliforms. In addition, Habteselassie *et al.* (2010) stress that *Escherichia coli* develops close to the roots of the plants and can contaminate the culture of the young growths. It can

live during weeks around the roots of the plants and be transferred towards the edible parts.

Table 1. Presence of cadmium on the samples of water of watering.

Sites	G	H	F	A
Samples of watering water (mg/L)	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000
Average	**0.000a**	**0.000a**	**0.000a**	**0.000a**
± Standard deviation	0.000	0.000	0.000	0.000

Generally, water of watering used on the market-gardening sites are contaminated by the fecal coliforms except for the witness site of Glo-Djigbé This difference could be explained by the system of watering used. Indeed, on the site of Glo-Djigbé, the market-gardeners use the tap of the National Company of Water whereas on the other sites, the ground systems of marsh dug (Houeyiho and Agongbomey) and drilling (Fidjrosse) are adopted. Water of watering of Houeyiho is polluted by fecal coliforms than those of Agongbomey and Fidjrosse. The results of this study are in agreement with those of Akodogbo (2005) which stress that the water of drilling is polluted than that of the wells (grounds dug of marsh). This author remarked in addition that the majority of the well rivers and drilling of Cotonou are invaded by the coliforms.

It is the same for *Escherichiacoli* absent on the site of Glo-Djigbé but present on the other market-gardening sites. That confirms well this water of watering knew a recent fecal contamination. This is possible insofar as the majority of the aforesaid sites have a considerable insalubrity (human excrements and other waste). The depth of the wells is also a factor very significant because more water infiltrates, more it gets rid of its impurities; however the majority of the sources of watering of the market-gardening sites are located in hollows and are not deep. None water of watering, put besides those of the site of Glo-Djigbé meets the standards varying between 100 and 200 UFC/100 ml for the coliforms and *Escherichia coli*, proposed by Santé Canada (1991).

Contamination of the water of watering by cadmium

The water samples of watering are not contaminated by cadmium. It proves that without its contamination by lead, these water are free of cadmium. It seems water of watering of the sites of study does not present major risks while being used to sprinkle the seedlings. Cadmium is an extremely toxic heavy metal which is widely used in mining, metallurgical operation, electroplating industries manufacturing vinyl plastics, electrical contacts, metallic and plastic pipes (Osman *et al*., 2009). As the sites are not in industrial area, the results of our study prove that cadmium is really an industrial metal. However, with the presence of lead (Dougnon *et al*. (b)., 2012), some precautions must be taken in order to cleanse the environment of culture as well as possible. It has been proved by Edorh *et al*. (2009) that *Achatina achatina* accumulated heavy metals, near to the legumes washed. With this intention, the use of well-maintained drillings seems better adapted contrary to the grounds dug of marsh which are very quickly polluted.

Conclusion

The water of watering used in urban agriculture in Cotonou is contaminated by the fecal coliforms beyond the authorized standards. It should not be used for that or at least undergo a certain cleansing. In spite of the absence of cadmium in this water, it forecasts new prospects as regards medical quality for the market gardenings in Cotonou.

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