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Microbiology and parasitology assessement of irrigation water used for production of vegetables in Ouagadougou, Burkina Faso

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INTRODUCTION

The image of famine and malnutition glue Africa. Indeed, some Sub-Saharan African countries with certain difficulties in food production are obliged to import commodities such as rice and other foodstuffs[1-3]. Burkina Faso is not immune to this kind of situation. Moreover, the country is experiencing cyclic food crises with climate hazards, poverty and conflict as main causes.

Despite efforts over many years to curb hunger and malnutrition, we must recognize that food insecurity is still a daily reality in Burkina Faso. Nearly half the population (46.4%) live below the absolute poverty and do not get to meet their basic needs. This is certainly food insecurity in the country but especially in town where all the food must be purchased. In fact, the low purchasing power, unemployment and underemployment are at the origin of food insecurity. Because of this situation, an significant segment of the population invent new solutions in order to survivel. It is there, that urban agriculture has been developed with gardening as the main activity in most West Africa cities[4-6]. For example in Ouagadougou approximately 40,000 people pratice this activity for their livelihood[5-7].

The practice of urban gardening still knows many constraints. In addition of land insecurity problems, land degradation, the gardeners of Ouagadougou, unlike their counterparts in Bamako, Cotonou, Abidjan, face a problem of water scarcity[4]. It should be noted that it is weak in terms of the availability of resources stored and distributed as the major constraint arises.

In response at this situation, many dams have been built. Indeed, to sixtie kilometer around Ouagadougou, there was only one hydro-agricultural site built in 1960, four in 1975, twenty today[7]. But it is clear that despite these developments, wastewater reuse is palliative trendy among urban gardeners[5,6,8]. The sanitary risks arising from such practices are far from negligible[9,10].

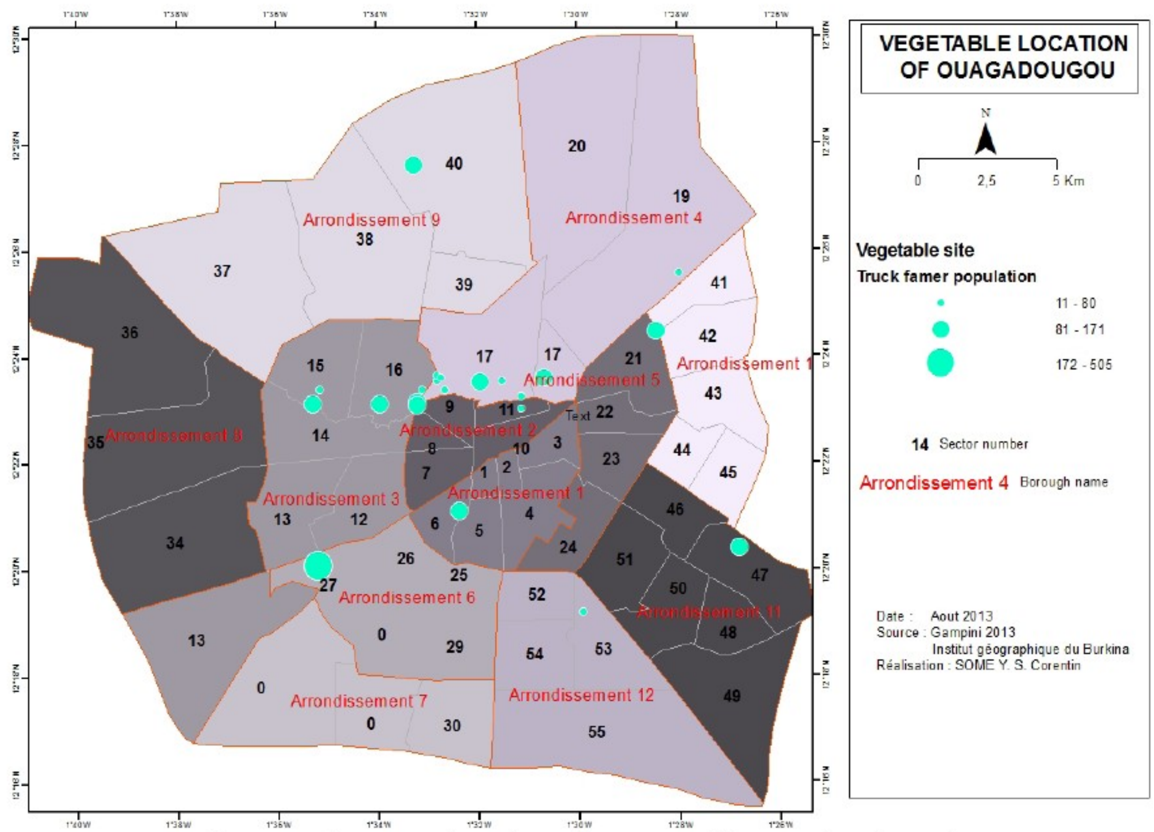
Indeed, despite the fact that these waters are a potential fertilizers (nitrogen and phosphate materials), their levels of heavy metals and pathogens, are nevertheless risks of contamination of soil, groundwater, plant and risk health for humans and animals[11-13].

This work aims to study the microbiological and parasitological quality of irrigation water of vegetables in Ouagadougou.

MATERIALS AND METHODS

Study area and period

The study took place in Ouagadougou the capital city of Burkina Faso (12°22'N, 1°31'W). This city is situated in a Sudanese savannah zone with low and highly variable rainfall. There is one rainy season. During the dry season, and particularly from January to March, the climate is very dry and dusty resulting from the Harmattan. In Ouagadouggou city, there are several dams that are used for gardening. These reservoirs are fed by rainwater and wastewater from the city. Ouagadougou is subdivided in 12 districts. The sampling was carried out in 09 of these districts. In total 24 gardening sites



Map 1 : Map of Ouagadougou showing the vegetable production sites

were visited for the collection of water samples. These sites are shown on the Map 1.

The present survey was conducted from February to June 2013 and had two stages. Firstly, the localization and characterization of vegetable gardens of Ouagadougou were carried out and then the vegetables irrigation water was analysis.

Location and characterization of vegetable garden sites

In cross-sectional surveys, market gardening sites were georeferenced. Information such as the nature of the site, the number of growers on the site, the type of irrigation water, use of pesticides and speculation produced were reported.

Samples collection

Samples for bacteriological analysis were collected using a borosilicate glass bottle with a capacity of 500 ml. These flasks were previously sterilized at 120°C and subjected to a pressure of 120 kg/cm2 for 30 minutes. Collected samples were labeled, stored in a refrigerated cooler and transported immediately to the laboratory for examination. A total of 69 water samples coming from dams (04), ditches, drainage channels rainwater and wastewater (06) and wells (59), were collected on all the 24 points where there are vegetable crops.

For parasitological analysis, 56 samples of 5 liters each were collected randomly between 8 am and 11 am in sterile plastic containers on all sites of the city. The samples were kept in a refrigerated cooler and transported to the laboratory for analysis. It should be noted that the volume of water withdrawn was determined in agreement with the findings of the study conducted by Schwartzbord and *al.*[14]. The frequency of this sampling was a gathering session per week.

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Samples processing

Bacteriological analysis

Fecal coliform (FC), total coliforms (TC) and Fecal Enterococci (EF) were quantified in this study. These indicators were counted by the method of filtration through a membrane filter with a 0.45 µm pore diameter for lightly laden water (well water or wells, dam etc.) and by the agar incorporation technique for wastewater and treated wastewater. Fecal coliform (FC) and total coliforms (TC) were cultured on agar Chromocult coliform. This culture medium was incubated at 37°C for FC and 44°C for TC during 24 hours. For Fecal Enterococci (EF), the culture medium was carried out on Bile Esculine Azide (BEA) after incubation at 37°C for 24 hours.

Parasites quantification

In the laboratory, water samples were sieved poured into trays and allowed to settle overnight[15]. The residue settling, or base, was used after concentration for qualitative and quantitative analysis. Parasite concentraction was done by using modified Bailenger method as recommended by World Health Organization[16]. Briefly, after centrifugation of an aliquote of 1.5 ml of water sample in an acetoacetic buffer and ether, the pellet obtained was added to a solution of zinc sulfate to 33% (density = 1.18) to allow the eggs to adhere to the Mac Master cell and facilitate their counting under microscope. We modified this protocol by removing the ether to not affect the viability of parasitic elements that may be in the samples. The slides were readed using x10 and x40 objective under light microscope. Parasites were identified by the morphological structures of their cysts, ova or larvae when focused under the microscope. The viability of parasitic elements was determined with safranin according to De Victorica and *al.*[17] method. Eggs and oo/cysts that absorbed the dye are considered viable.

The total number of parasites per liter of water sample (N) was calculated using the Formula :

N = A. X / P. V,

with A = number of parasites counted on the Mac Master slide; X = volume of the final product (ml) and P = Mac Master room capacity (0.3 ml)

RESULTS

Market gardening sites characteristics

Five thousand three hundred and ten market gardeners (5310) share these sites. The most popular sites are: Boulmiougou, Tanghuin, Kossodo. All the sites listed are permanent. Speculation produced are diverse and vary from one site to another. In addition, as shown in Figure 1, the water used for irrigation of these speculations on vegetable sites are composed mainly of water of wells (66.4%), water of dam (21.8%), wastewater (0, 7%), drilling (2%), treated wastewater (0.7%). Moreover, on all sites, organic manure (composed of animal waste and plant debris) and chemical fertilizers (urea, NPK) are by far the most fertilizers used.

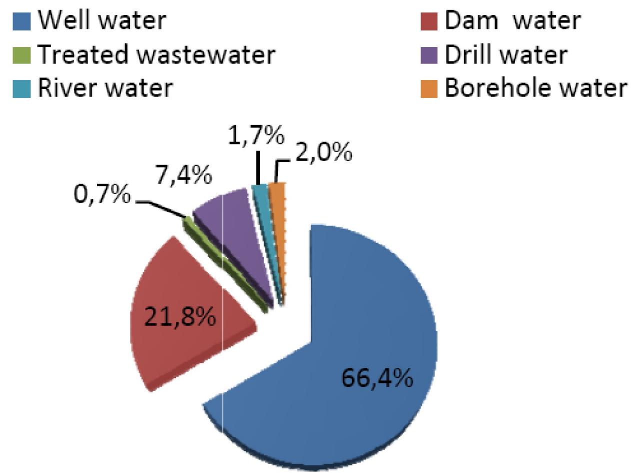

Figure 1 : Distribution of vegetable growers depending of type of irrigation water

As a reminder, the physico-chemical parameters measured were temperature and pH. To evaluate them, we used the average. Thus, the average temperature of the irrigation water of vegetable crops in the city of Ouagadougou was 29.78°C, with a maximum of 31.73°C. The average pH was 8.23 with a maximum of 10.6 and 5.6 minima. It is noted that the temperature and pH of wastewater (raw or processed) used for irrigated crops remained in the same range.

Bacterial load characterization

The results of the weekly analyzes of irrigation water of vegetable crops at Ouagadougou reveal the presence of indicators of fecal contamination. Indeed, 66.7% (46/69) of the water samples analyzed, countain Fecal coliforms (FC),, total coliforms (TC). As shown on the Map2, Fecal coliforms were the most prevalent bacteria, followed by Enteroccus and *Escherichia coli*. The concentrations vary between 10/100 ml and 3.860/100 ml for FC, between 11/100 ml and 13 / 100 ml for *Escherichia coli*, and 12/100 ml to 2380 / 100 ml for Fecal Enterococci (EF). These

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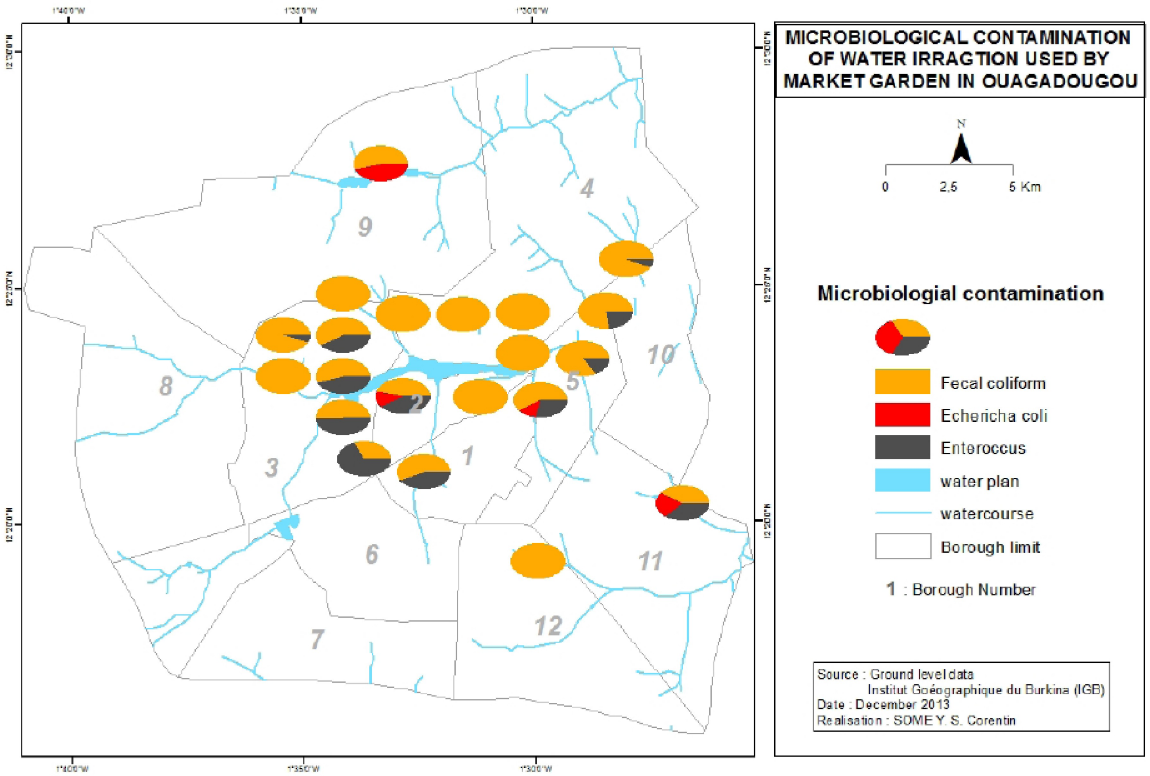

Map 2 : Map showing the microbiological contamination level of water irrigation used for vetegetabes production in Ouagadougou

concentration of FC, TC and EF are more important in the irrigation water of vegetable sites of Wayalgin (1543/100 ml of FC and 619 /100 ml of EF), followed by Kossodo (500/100 ml of FC and 30/100 ml of EF) and Boulmiougou (450/100ml of FC and 40/100ml of EF) where irrigation water are raw wastewater, treated wastewater and well water respectively Map 2.

Parasitological load characterization

Parasitological analyzes of irrigation water of vegetable crops in the city helped highlight eggs from two groups of helminth parasites: nematodes and cestodes and protozoan cysts of coccidia class. Identified species were respectively *Ascaris lumbricoïdes* (6 eggs / L), *Ancylostoma duodenalis* (7 eggs / L), *Taeniasis* spp. (27 eggs / L) and *Hymenolepus nana* (7 eggs / L), for helminths and *Entamoeba histolytica* (4 cysts / L) for protozoa. TABLE 1. No representative of the group of trematodes were found in the samples analyzed.

It should be noted that only 20% of eggs and cysts was viable.

The distribution of these parasites was represented on Map 3. As shown by the distribution map, all types of irrigation water are contaminated with parasites. Wastewater were carried more parasitic species than others. Indeed the 5 parasitic species harvested, 4 are present in the wastewater. Also, for a kind of parasite the number of eggs collected is higher than in other types.

TABLE 1 : Helminths and protozoa parasites in irrigation water in vegetable crops in Ouagadougou

		parasitic species	Number of eggs / cysts	Waste water	Treated Waste water	Well water	Dam water
Helminths	Nematodes	Ascaris lombricoïdes	6 eggs/ L	+	-	+	+
		Ankylostoma duodenalis	6 eggs/L	+	-	-	-
		Hymenolepus nana	7 eggs/L	-	+	-	-
	Cestodes	Taenias Spp.	27 eggs/L	+	+	-	+
Protozoans	Coccidian	Entamoeba histolytica	4 cysts/L	-	+	-	+

+ : presence; - : abscence

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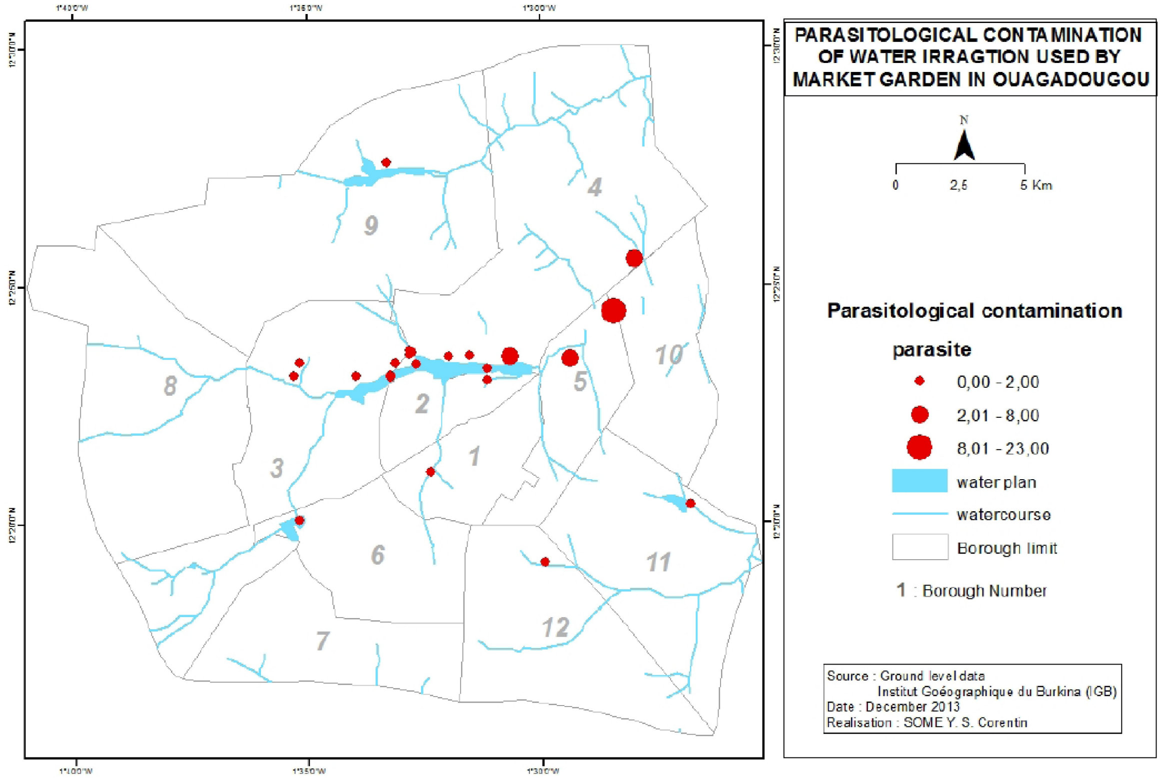

Map 3 : **Map showing the parasitological contamination level of irrigation water used for vegetables production in Ouagadougou**

The parasite species tapeworms spp. illustrates this. Of the 27 eggs of tapeworms spp collected a total of 20 eggs were from sewage against 5 and 2 wells and dam water respectively.

DISCUSSION

Geographical surveys found 24 locations in the city, spread over 14 sectors, where vegetables were seen in the dry season. This is less than the number inventoried by Cisse and *al*.[18] which had listed 32 in the same season. Water resources used are well water, dams water and channels water. These results are in agreement with those report by Cisse et al.[18], but are contrary to those reported by Koné and *al*.[19] as to the amount wastewater used and surfaces irrigated by these water.

It know that water is an important resource that supports life of all living organisms and is used for different purposes including drinking, and vegetables cultivation. Polluted water is an important vehicule for biological agents[20] that can be transmitted by direct contact and/or indirectly through consumption of crops irrigated[21]. Their recovery in water used as the source of contamination, may be helpful in indicating the incidence of intestinal and skin disease[22] among a community. The survey of irrigation water of vegetables found concentration of microorganisms composed by bacterial and parasites. except wastewater, bacterial pollution levels recorded are below recommended by WHO for unrestricted irrigation of vegetable crops thresholds.

As regards the parasitological characterization of irrigation water for vegetable crops in Ouagadougou, the type of parasites is varied. Unlike previous work in the same context[18] it is composed of helminths and protozoan. This could be explained by the greater number of sites involved in sampling the one hand, and the method of quantification of parasites used on the other. Even if we agree to say that there is no standard method for sampling and detection of helminths and protozoans in environmental matrices[23-25], it remains that several authors have demonstrated that the method was modified Bailenger most effective[16,26]. Indeed, this easy method of application not only allows quantification of helminths but also protozoa. This is not the case for the SAF (Soduim acetate- Acetic acid - Formalin) concentration technique which mainly focuses on the detection of helminthes[27]. In addition, qualitative analysis identified two groups of helminths in the samples: Nematodes and Cestodes. This is in agreement with observations made by Cisse and *al*.[28], with a slight predominance of nematodes. This difference is related to the intrinsic resistance of helminths belong nematodes class to environmental conditions. Indeed, Schwartzbrod and al.[29]; Ben Ayed and *al*.[30] reported that the eggs of the nematodes class are more resistant than the Cestodes class in waters. Furthermore, no representative of the class of trematodes were encountered during the study. This observation is in agreement with the assertion of Jimenez[31] which stated that only nematodes and cestodes had significant health in assessing the parasitological water quality in general and in particular wastewater.

Finally, our study shows that although all types of irrigation water of vegetable crops were polluted, the parasitic load is higher in wastewater than other types. This support the several epidemiological studies around the world which have revealed an excess of parasitic infestations associated with raw wastewater reuse in irrigation[21,22].

CONCLUSION

Analysis of the types of water irrigation use on vegetable sites Ouagadougou shows that all types of water, even well water present parasitological and bacteriological pollution. While, except wastwater, bacterial pollution levels recorded are below recommended by WHO for unrestricted irrigation of vegetable crops thresholds, this is not about the parasitological contamination. This is particularly worrying for raw and treated wastewater which have higher levels of pollution. They prove in fact more dangerous for the health of growers who use them daily heath.

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COMPETING INTERESTS

Authors have declared that no competing intersts exist

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