

Assessment of the Level of Microbiological Contamination of Market Garden Waters in the City of Daloa (Ivory Coast)

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Abstract: The city of Daloa located in the center-west of the Ivory Coast chief town of the Haut-Sassandra region since 1996 has a significant market gardening activity in the slums of the districts of ABATTOIR, COMMERCE CIE, ORLY, MARIN, COMMERCE CROU D and HUBERSON. A study from May 2017 to August 2017 in this geographical unit, had as main objective to determine the level of microbiological contamination of wastewater used in market gardening, to evaluate the health risk for fresh vegetables and to contribute to the reduction of negative impacts induced. It emerges that the water of the Daloa town's lowlands used for watering plants is polluted by wastewater and solid waste from households, markets, and have significant levels of streptococci (495 PDU) / mL at 1.850×10^3 UFC / mL), in *Salmonella* (2×10^3 UFC / mL), in *E. coli* (290 UFC / mL at 1.082×10^3 UFC / mL), in *P. aeruginosa* (521 UFC / mL at $1,26 \times 10^3$ UFC / mL), *S. aureus* (135 UFC / mL at 360×10^3 UFC / mL) and *V. cholera* (95 UFC / mL at 337 UFC / mL). Many practices and numerous risky behaviors have been observed and contribute to the spread of waterborne diseases. Despite the risk of waterborne diseases, this activity contributes significantly to improving the living conditions of the categories of actors involved in this activity.

Keywords: Urban Market Gardening, Wastewater, *Salmonella*, *E. coli*, *S. aureus*, *P. aeruginosa*, *V. cholera*, Streptococci, Pathogens, Microorganisms

Introduction

The city of Daloa in Côte d'Ivoire, like most cities in developing countries (DCs), has been marked over the past three decades by an exponential increase in population

This rapid population growth inherent in a natural increase of the population results in the densification of the urban space, the strong pressure exerted on the natural resources and the intensification of the poverty of a more and more important fringe of the urban households

In this surge of survival, the colonization of swampy lowlands for agricultural purposes, with a clear predominance of market gardening seems quite marked (Kouam-Kenmogne *et al.*, 2010). This fast-growing activity in the city of Daloa contributes to the city's supply of food, increased household income (Olanrewaju *et al.*, 2004, Broutin *et al.*, 2005, UNDP, 1996)

In spite of these various assets which militate in favor of its valorization, the market gardening as practiced in the lowlands of the city of Daloa is questionable

considering the sites of exploitation (swampy bottom-fund) and the microbiological quality of water used.

The repetitive impacts on surface waters caused by anthropogenic waste seriously jeopardize the quality of this resource, which is unfortunately reused in its raw state (without prior treatment) for the production of vegetable crops

The reuse of partially or untreated wastewater in agriculture is widespread in African cities (Cisse *et al.*, 2002). According to FAO (2007), 200 million urban farmers worldwide would use untreated or partially treated wastewater.

Given these different pressures, the question arises of the credit granted to the products (vegetables) resulting from this activity. In other words, what are the health risks to take into account in view of the great microbiological complexity of the constituent elements of these swampy lowlands and wastewater?

This is the approach that guides this study, which proposes to evaluate the level of contamination of wastewater by potentially pathogenic bacteria in



urban market gardening with the aim of bringing together with stakeholders effective solutions to reduce negative impacts and value the positive aspects.

Material and Methods

Study zone

The city of Daloa located in west-central Côte d'Ivoire is the capital of the Haut-Sassandra region since 1996. Daloa is at the junction of several highways including Abidjan-Guinea (East-West), San Pedro-Mali (North-South), Man-Abidjan and Odienne-San Pedro. This situation makes it a place of passage, both for the transport of goods and for the transit of many migrants who frequent these axes.

Sampling

Sampling sites

Six (6) sites were selected for this study. These are the sub-districts of Abattoir, Commerce CIE, ORLY, MARIN, COMMERCE CROU D and HUBERSON.

Sampling

After washing your hands and wearing clean disposable gloves, the sample is taken by immersing the 250 mL sterile jar at a depth of about 50cm from the surface. The pot is then opened. Once filled, the sterile jar is closed under water to prevent the formation of air bubbles and any risk of contamination. The pot is labeled and placed in a cooler containing cold accumulators (+ 4 ° C) and transported to the laboratory for analysis.

Preparations of culture media

The preparation of the culture media was made according to the manufacturer's instructions on the middle box.

Preparation of dilutions from samples

A stock solution has been prepared. Thus, 25 mL of the solution to be analyzed were removed aseptically and added to 225 mL of sterile buffered Peptone Water (PHE) and homogenized for 2 min. The solution obtained was called stock solution (SM).

For dilution, 1 mL of the MS is removed and added to 9 mL of sterile distilled water to have a 10^{-1} dilution. 1 mL of the 10^{-1} dilution is withdrawn and added to 9 mL of sterile distilled water to obtain the 10^{-2} dilution. This operation is repeated until a 10^{-4} dilution solution is obtained

Bacteriological analyzes

Salmonella search

Seeding SS medium for Salmonella isolation

0.1 mL of each dilution (10^{-1} , 10^{-2} , 10^{-3} and 10^{-4}) was aseptically transferred into the tubes containing 10 mL of the corresponding Rappaport Vassiliadis (RV) medium. The tubes were incubated at 37 ° C. and then observed after 24 hours. Then, using a sterile platinum loop, a quantity of the broth is removed and then streaked onto the SS medium. The dishes are incubated at 37 ° C. and then observed after 24 hours.

Investigation of *S. aureus*, *V. cholerae*, *E. coli*, *P. aeruginosa* and Streptococci

0.1 mL of each dilution (10^{-1} , 10^{-2} , 10^{-3} and 10^{-4}) is removed and then aseptically deposited on the surface of Baird Parker Agar (*S. aureus*), Rapid *E.coli* Agar (*E. coli*), Cetrinide agar (*P. aeruginosa*), TCBS agar (*V.cholerae*) and BEA agar (Streptococci) contained in the petri dish. Then using a sterile rake, a uniform spread on the surface of the petri dish is achieved. The dishes were incubated at 37 ° C. and then observed after 24 hours.

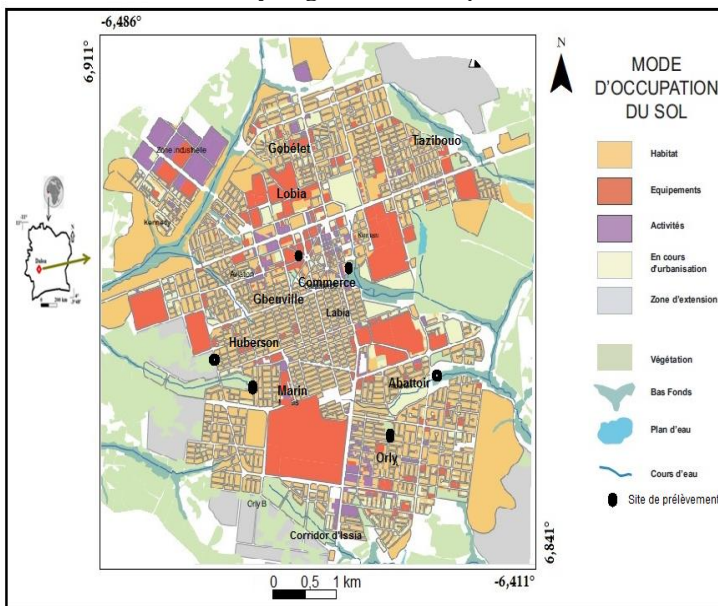


Figure 1: Map showing the area and sites of the study (BNETD, 2007).

Choice of the study area

This forest town with an agricultural vocation is a real center of trade and transport. In 2014, it had 275,277 inhabitants and 42 neighborhoods with an area of 5,305 hectares, which corresponded to a density of 52 inhabitants / km² (INS-RGPH, 2014). As a result, Daloa attracts people from other cities in the country and those in the sub-region.

Framework of the study

This study was conducted on six (06) sites composed of swampy lowlands (for the collection of wastewater samples) and the Microbiology Unit of Jean Lorougnon Guédé University (Daloa) for microbiological analyzes.

Identification of isolated bacterial species

The identification was made by a macroscopic observation of the appearance of colonies on culture media, followed by a fresh state. Then the catalase test and the Gram stain are performed. Finally biochemical tests confirm the bacterial species.

Results

Collection of samples

The collection of wastewater samples was carried out in six swampy lowlands (where market gardening is practiced) in the city of Daloa from May 2017 to August 2017, over a period of four months. The number and percentage of samples collected at each site are contained in Table I.

Table I: Distribution of samples by sampling location

Sampling area	Number of samples collected	
	Number	Percentage (%)
ABATTOIR	22	21,78
COM CIE	18	17,82
COM CROU	11	10,89
HUBERSON	17	16,83
MARIN	20	19,80
ORLY	13	12,87
TOTAL	101	100

Microbiological analyzes

Six potentially pathogenic microorganisms (Salmonella, *S.aureus*, *E. coli*, *P. aeruginosa*, *V.*

cholera and Streptococci) were searched for in each sample collected. The results of the bacteriological analyzes are shown in Table II.

Table II: Results of microbiological analyzes of water samples taken from the slums of the city of Daloa

Echantillons	Salmonella (UFC/mL)	<i>E.coli</i> (UFC/mL)	<i>S.aureus</i> (UFC/mL)	<i>P.aeruginosa</i> (UFC/mL)	<i>V. cholera</i> (UFC/mL)	Streptocoques (UFC/mL)
Abattoir	2 10 ³	1,082 10 ³	135	950	321	1,850 10 ³
COMCIE	2 10 ³	984	360	1,26 10 ³	337	771
COMCROU	2 10 ³	420	00	00	00	426
HUBERSON	2 10 ³	290	00	00	00	1,11 10 ³
MARIN	2 10 ³	720	00	521	95	1,023 10 ³
ORLY	2 10 ³	600	00	00	00	495

The different values of the microbiological parameters indicate a presence of Salmonella and *E. coli* on all the studied sites with values exceeding the directives enacted by the WHO which recommends less than 1000 CFU / 100 mL. On the other hand, *S. aureus*, *P. aeruginosa* and *V. cholera* are absent on certain sites.

Discussion

The practice of market gardening is subject to several constraints (poor water quality, health risks, etc.) which constitute obstacles to its development. These different problems that do not seem to be the preserve of the Daloa city's lowlands have also been noted by authors in other cities in developing countries (Cisse *et al.*, 2002, Niang, 2002). The quality of water is no doubt a permanent burden. The microbiological analyzes of the waters have revealed the existence of pollution in relation to the sources of contamination in all the sites.

Thus, the results of this study show us that the Slaughterhouse and COMCIE sites contain the six

germs that were searched for. While for the other four lowers it was noted an absence of these bacteria a few times. According to Dawe and Pentose (1978), Gauthier and Pietri (1998), the survival of these microorganisms varies from one site to another and from one season to another; as a result, the intrinsic quality of the receiving environment plays an important role in the future of germs in the natural environment. Among the germs sought, the strains of *E. Coli*, Streptococcus and Salmonella were the most common on our various sites. *E. coli* is reported to have good growth at near neutral pH, between pH 6 and 8, and is able to withstand extreme temperatures ranging from 8 ° C to 48 ° C (Neidhardt *et al.*, 1994). On the other hand, the absence on some sites of *S. aureus*, *P. aeruginosa* and *V. cholera* in our study does not in any way mean their non-existence. Their absence could be explained by a number of hypotheses. The bibliographical data relating to this subject are very varied because the concentration of these pathogenic bacteria in the wastewater depends on the epidemiological and environmental conditions

of the regions where they are carried out (El Ouali *et al.*, 2014)

Once released into the wild, these bacteria face adverse conditions such as nutrient limitation, osmotic stress, low temperatures and pH variations, and multiple predators. All of the samples analyzed largely deviate from the guidelines prescribed by WHO (WHO, 1989) which recommend less than 10^3 UFC / 100ml for these bacteria. This polluted nature of the resource, a logical result of the pollution sources in the Daloa lowlands, shows the great vulnerability to which people are subjected to contact with these waters in the framework of market gardening activities. In this, the resurgence of waterborne diseases that affect market gardeners as well as retailers and consumers find some answers. These health risks are unfortunately exacerbated by numerous behaviors and practices at risk (no wearing of appropriate equipment, contact with wastewater).

Urban market gardening, despite the problems it poses (health impacts, etc.), fulfills many functions: reducing the unemployment rate, supplying the city with food, upgrading vacant land, recycling waste and wastewater, maintaining the aesthetics of the city (Kouam-Kenmogne *et al.*, 2010). As such, it is appropriate for each actor (State, NGO, market gardener, retailer, consumer) to work for a harmonious and sustainable development of this activity.

Conclusion

This study revealed the importance of urban market gardening in the city of Daloa. The wastewaters used from the lowlands where the maraicher is practiced which are the subject of our study are relatively charged with seeds with pathogenic potentiality.

The polluted nature of the environment as well as the water used for watering plants is a risk factor for market gardeners as well as for the populations who consume the vegetables produced. Many benefits are derived from this activity which only needs to be framed to minimize the negative aspects. If we consider the positive aspects of this activity, it is important to take care of it for present and future generations.

In the specific context of market gardening practiced in the slums of the city of Daloa, it is important for future research work:

- to spread our study over a large area (several sites) for a long period with several samples.
- determine the average load of all DALOA pathogens
- Study (identify and characterize) all the germs sought
- realize the antimicrobial resistance of the desired germs

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