

Assessment of Health Risk Factors Associated with Conditions of Lettuce (*Lactuca sativa*) Sale in Abidjan (Côte d'Ivoire) Markets

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ABSTRACT

This study was conducted to identify the different risk factors related to conditions of sale of vegetables and the general sales environment. The marketing of lettuce is generally an activity assigned to women (100%) between the ages of 15 and 35 (76.4%) although 48.7% do not have any formal education. The highest percentage of sales was realized by the women from Adjamé (56.7%), followed by those of Port Bouet (51.5%) and Koumassi (46.5%). Marcory women sold less lettuce (14.8%) but more of other vegetables (43.8%). The immediate surroundings of sales points are real sources of contamination (garbage, public toilets, open channels, etc.). In Adjamé, 58.5% of the vegetables are exposed to garbage, followed by Plateau (50%). In Abobo (17.1%) and Port Bouet (15%), vegetables are sold close to public toilets. The majority (52.4 to 89.5%) of the traders do not protect lettuce during marketing. Vegetables were most of the time exposed to air, sold in stalls or in plastic bags, sometimes not displayed in baskets and exposed directly to the floor without any protection (71%). After marketing, 58% of the women conserved the unsold lettuce during the day at the stalls used to sell it. In Attécoubé, 100% of the unsold lettuce is kept at the market, in Adjamé, 16.07% of the unsold lettuce is stored at home while in Treichville, 40% of the vegetables are stored in a cold room. The site of sales and the risks of exposure to vegetables during the selling period are potential risk factors for microbial contamination of food. Improper handling and hygiene might lead to the contamination of fresh lettuce which can eventually affect the health of and pose serious health hazards to consumers.

Keywords: contamination, marketing, public health, sale environment, sale outlets, vegetables

INTRODUCTION

This study was conducted to identify the different risk factors related to sale conditions of vegetables and the general sales environment to help understand the contamination of lettuce and other vegetables during marketing.

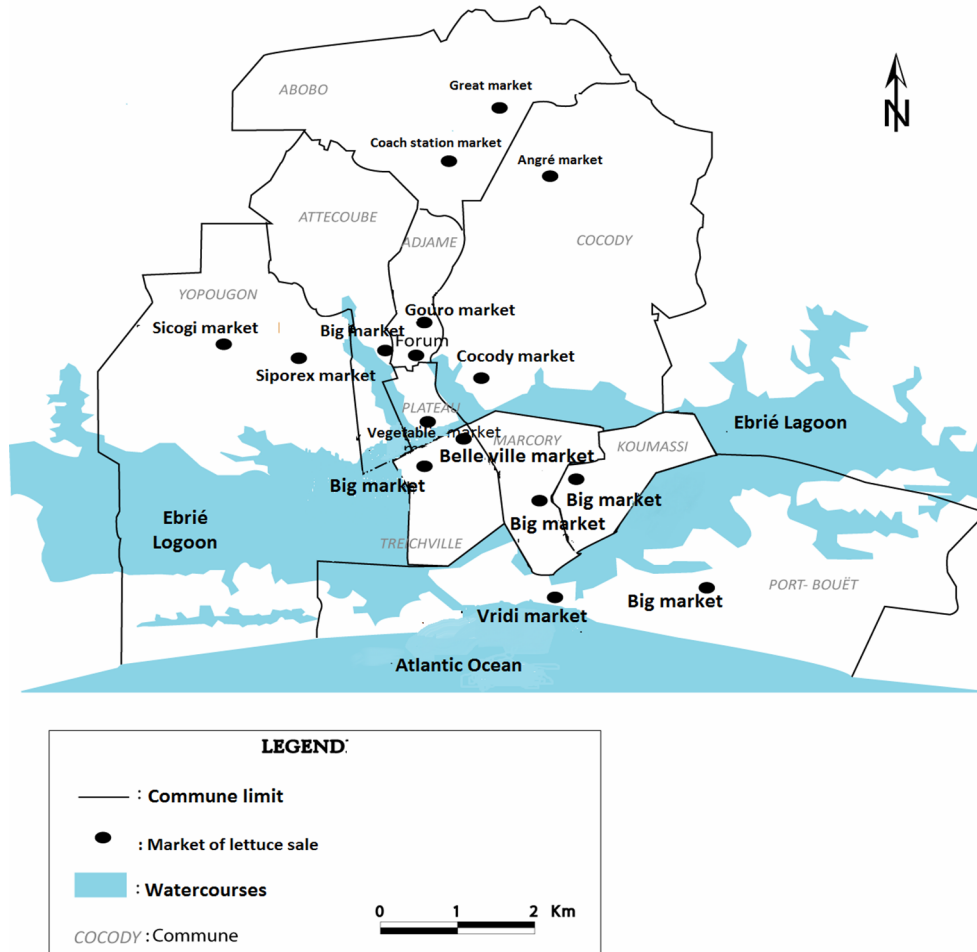
Developing countries face a high incidence of food poisoning, which has economic consequences. Although food-borne diseases remain a major public health problem worldwide, one of the most significant risks to food safety is associated with fruits and vegetables eaten raw (Heaton and Jones 2008; Berger *et al.* 2010; Petterson *et al.* 2010; Koffi-Nevry *et al.* 2011). Côte d'Ivoire is a sub-Saharan African country facing significant sanitation challenges. In Côte d'Ivoire, fresh salads are not part of the normal diet for low income households, but are a common supplement to urban fast food served by the street sides, in canteens and restaurants (Koffi-Nevry *et al.* 2011). Indeed, in this country, fruits and vegetables sold in supermarkets are not part of consumer behavior beyond those with very high incomes. Most consumers buy fruits and vegetables in open markets. Thus, the risk groups include all income classes, including the poor, elderly and children.

Fresh vegetables, fruits and leafy greens have gained importance (Amiot-Carlin *et al.* 2007). Among these leafy vegetables, lettuce (*Lactuca sativa*), commonly called "salad", is much appreciated. Fresh fruits and vegetables are important components of a healthy and balanced diet; their consumption is encouraged in many countries by governmental health agencies to protect against a range of illnesses such as cancers and cardiovascular diseases (Brazzano *et al.* 2003; Delagoutte 2006; Amiot-Carlin *et al.* 2007; Berger *et al.* 2010). The consumption of fresh produce has become a very common habit in the diet of the Ivorian people (Koffi-

Nevry *et al.* 2011; Kouassi and Koffi-Nevry 2012) for whom vegetables represent 15 to 20% of the food budget (Odounfa 1987).

If the benefits of regular consumption of these vegetables have been clearly demonstrated, there is some evidence that vegetables eaten raw are a source of microbial infection. Indeed, these fruits and vegetables are recognized as important vectors in the transmission of pathogens traditionally associated with the consumption of foods of animal origin (Brandl 2006; Berger *et al.* 2010). The consumption of fruits and vegetables is commonly viewed as a potential risk of infection with enteropathogens such as *Salmonella* and *Escherichia coli* O157, but also with viruses as shown by recent outbreaks linked to lettuce, spinach and tomatoes (Sagoo *et al.* 2003; Heaton and Jones 2008; Petterson *et al.* 2010).

Furthermore, a study conducted by Barro *et al.* (2002) showed that vegetables sold in the streets of Ouagadougou and Bobo-Dioulasso in Burkina Faso were the cause of 65% of cases of diarrhea and other digestive disorders. An epidemiological study conducted in France between 1996 and 2005 showed that lettuce was implicated in 5847 homes' collective food poisoning, with 45 deaths (Delmas *et al.* 2006). In Côte d'Ivoire, Sackou *et al.* (2006) reported that 75% of lettuce samples collected from markets in Abidjan did not meet the microbiological criteria set up for vegetables. According to the same authors, 44% of the consumers in Abidjan do not use any disinfectant to wash raw edible vegetables. This work also revealed the presence of thermo-tolerant coliform on almost all the lettuce samples analyzed. The lack of hygiene related to the level of education was the cause. Furthermore, a study conducted by Koffi-Nevry *et al.* (2011) showed that lettuce samples sold in the market were more contaminated with Enterobacteria than lettuce samples



Conception, Réalisation: Hoznin, 2010

Source: BNETD

Fig. 1 The map of Abidjan city with its various communes and markets.

from the sites of production. With many cases of typhoid fever, cholera and gastroenteritis in Abidjan (Adiko 1996; Sackou *et al.* 2006), it seems important to identify the different risk factors associated with the conditions of sale of vegetables to markets by a general sales prospectus through a survey.

MATERIALS AND METHODS

Survey

A survey was conducted in 10 markets belonging to the 10 communes of Abidjan, Côte d’Ivoire, to understand the conditions of sale of vegetables. The study population consisted mainly of sellers. For this purpose, a questionnaire was developed (see **Appendix**) to identify the characteristics of the sellers (age, sex, educational status, origin of sellers, level of vegetable sale, conditions of lettuce sale, management of the unsold lettuce level), and the vegetables’ sales environment. This investigation lasted eight months and was realized on the sale of lettuce (*Lactuca sativa*). The ten communes of Abidjan are: Adjamé, Abobo, Attécoubé, Koumassi, Treichville, Marcory, Cocody, Plateau, Yopougon, Port bouet (**Fig. 1**). The survey covered a total of 194 lettuce sellers distributed as follows: Adjamé (38), Abobo (21), Attécoubé (9), Koumassi (20), Treichville (7), Marcory (12), Cocody (13), Plateau (10), Yopougon (39), Port Bouet (25). The information collected from respondents was expressed as percentages.

Statistical analysis

The data obtained on the characteristics of the sellers and the conditions of lettuce sale were submitted to an analysis of variance. With respect to the conditions of lettuce sale investigated during health risk factors assessment, the mean values between sellers

were compared. In order to determine which means for each condition of sale were significantly different from others, differences between means were assessed by Neuwman-Keul’s multiple range test at $\alpha = 0.05$ (Musyimi *et al.* 2008).

RESULTS

The respondents were all women (100%) between the ages of 15 and 35 (76.4%). Almost half (48.7%) attested not to have any formal education, 17.5% said they attended

Table 1 Percentage distribution showing socio economic characteristics of vegetable sellers in the markets of Abidjan.

Characteristics of respondents	Distribution	
	Frequency	Relative %
Age (years)		
15-25	48	24.6
25-35	100	51.8
35-45	39	20
> 45	07	3.6
Total	194	100
Gender		
Male	-	-
Female	194	100
Educational status		
No formal education	94	48.7
Primary school	54	28
Secondary school	34	17.5
High school	12	5.8
Origin of sellers		
Non-native	172	88.7
Native	22	11.3

Table 2 Relative % of sale of vegetables according to the commune.

Communes	Lettuce only	Lettuce + other	Other vegetables
Adjamé	56.7 ± 2.3 a	9.7 ± 3.3 c	33.5 ± 1.8 b
Abobo	40.5 ± 3.5 ab	31.6 ± 1.6 b	27.9 ± 1.8 b
Yopougon	30.2 ± 2.2 bc	31.8 ± 2.8 b	38.0 ± 3.2 a
Port bouet	51.5 ± 2.8 ab	16.8 ± 1.7 bc	31.7 ± 2.3 b
Attécoubé	28.3 ± 4.5 b	29.7 ± 2.2 b	42.0 ± 2.8 a
Marcory	14.8 ± 1.5 bc	41.4 ± 2.2 b	43.8 ± 3.0 b
Treichville	42.8 ± 2.4 ab	21.6 ± 2.6 c	35.6 ± 3.0 b
Plateau	44.9 ± 4.6 ab	28.7 ± 2.2 bc	26.4 ± 2.30 b
Cocody	38.0 ± 3.6 a	29.0 ± 3.2 ab	33.0 ± 2.0 a
Koumassi	46.5 ± 1.5 a	32.8 ± 1.8 b	20.7 ± 2.7 c

Means with the same letter superscript on the same line or column are not significantly different ($P < 0.05$)
± means standard deviation

Table 4 Conditions of sale of the lettuce in the markets of Abidjan.

Communes	Lettuce protected	Lettuce unprotected
Adjamé	10.5 ± 2.1 b	89.5 ± 3.5 a
Abobo	42.6 ± 1.4 b	57.4 ± 8.6 a
Yopougon	21.2 ± 1.1 b	78.8 ± 8.5 a
Port bouet	29.5 ± 3.0 b	70.4 ± 1.1 a
Attécoubé	25.0 ± 6.4 b	75.0 ± 6.3 a
Marcory	33.3 ± 5.4 b	66.7 ± 3.5 a
Treichville	25.0 ± 5.4 b	75.0 ± 5 ab
Plateau	38.1 ± 1.9 ac	52.4 ± 3.7 ab
Cocody	28.6 ± 5.4 b	71.4 ± 14.4 a
Koumassi	26.7 ± 1.2 b	73.3 ± 7.3 ab

Means with the same letter superscript on the same line or column are not significantly different ($P < 0.05$)
± means standard deviation

primary school, and none of them claimed to have attained a secondary education. About 88.7% of non-native women are involved in the marketing of vegetables versus 11.3% of native women (Table 1). Table 2 shows that the highest percentage of sales was realized by women from Adjamé, 56.7%, followed by those of Port Bouet (51.5%), Koumassi (46.5%), Plateau (44.9%) and Abobo (40.5%). Moreover, the sellers of Marcory who sell less lettuce (14.8%), produced the highest sales rate of other vegetables (43.8%) other than lettuce, followed by those from Attécoubé (42%).

A description of the environment of the vegetables' sales sites in the markets is provided in Table 3. In Adjamé, 58.5% of the vegetables sold are exposed to garbage, followed by 50 and 43.3% for Plateau and Abobo, respectively, and only 10.1% for Treichville. Also, in Abobo (17.1%) and Port Bouet (15%), vegetables are sold close to public toilets. However, in Attécoubé, Marcory, Treichville, Plateau and Cocody, vegetables are not displayed for sale around public toilets. No significant difference was observed between sellers that exposed their vegetables around public toilets and those who did not. Furthermore, in the immediate sales environment of Treichville and Marcory, various actual sources (dirty floor, mud, open gutters, etc.) of contamination were observed in 89.9 and 65.2%, respectively.

What has emerged from this survey is that the majority (52.4-89.5%) of sellers selected for this study do not protect lettuce during selling (Table 4). In Abobo, 42.6% of the

women cover the lettuce with a plastic bag although this practice was also observed by vendors from Plateau (38.1%) and by those from Marcory (33.3%). There was a significant difference between sellers that protected their lettuce and those who failed to protect them. The frequency of places where vegetables were stored in the market after the daily sale is given in Table 5. In Attécoubé, all (100%) the unsold lettuce was kept at the market, while 16.07% of the unsold lettuce of Adjamé was stored at home, followed by Port Bouet (15.2%) and Koumassi (10.7%). The results further showed that in Treichville, 40% of the vegetables were stored in a cold room unlike women from all the other sampling points who preserved their lettuce at ambient temperature at home or in small market stores. Koumassi recorded the highest number of women (67.9%) who maintained their vegetables, including lettuce, in a store, unlike Attécoubé, Treichville and Cocody where no sellers keep their vegetables in a store.

DISCUSSION

Throughout Africa, especially in Côte d'Ivoire, gender roles are associated with various activities such as production and marketing of lettuce. Men do not take part in the sale of vegetables to markets except for production and handling, because it is regarded as housework. This activity represents the main source of income for most of them. In

Table 3 Distribution (%) of the environment of the sale sites of vegetables in the markets.

Communes	Near garbage	Near toilets	Near open channels	Near other sources
Adjamé	58.5 ± 3.8 a	5.8 ± 0.4 b	9.2 ± 2.6 bd	26.5 ± 2.4 c
Abobo	43.3 ± 3.4 ac	17.1 ± 1.9 ac	2.8 ± 0.9 df	36.8 ± 2.2 bc
Yopougon	36.4 ± 3.5 bc	6.0 ± 1.0 bd	17.0 ± 2.0 c	40.6 ± 3.5 ac
Port bouet	38.4 ± 2.3 ac	15.8 ± 0.9 ac	15.1 ± 1.9 c	30.7 ± 4.9 bc
Attécoubé	34.3 ± 3.5 ac	00 ± 00 c	28.8 ± 2.2 b	36.9 ± 3.05 ac
Marcory	21.2 ± 2.0 bd	00 ± 00 cd	13.6 ± 1.2 c	65.2 ± 4.5 ab
Treichville	10.1 ± 2.6 be	00 ± 00 c	00 ± 00 cg	89.9 ± 8.3 ab
Plateau	50.0 ± 2.7 ab	00 ± 00 cd	6.3 ± 2.4 ce	43.7 ± 3.1 bc
Cocody	30.4 ± 3.4 bc	00 ± 00 cd	10.4 ± 0.9 c	59.2 ± 3.5 ab
Koumassi	37.4 ± 2.3 ac	5.3 ± 0.8 bc	36.8 ± 1.6 a	20.5 ± 2.3 bd

Means with the same letter superscript on the same line or column are not significantly different ($P < 0.05$)
± means standard deviation

Table 5 Frequency of storing unsold vegetables.

Communes	Store	Home	Cold room	Market
Adjamé	55.4 ± 23.3 ab	16.1 ± 1.9 ae	0.0 ± 0.0 be	28.7 ± 2.1 e
Abobo	35.4 ± 23.3 ab	11.9 ± 2.4 b	1.7 ± 0.6 b	61.0 ± 3.3 c
Yopougon	19.3 ± 4.1 bc	3.4 ± 1.2 bc	0.0 ± 0.0 bd	77.3 ± 8.0 b
Port bouet	43.5 ± 5.2 ab	15.2 ± 1.7 ab	0.0 ± 0.0 bc	41.3 ± 2.8 cd
Attécoubé	0.0 ± 0.0 c	0.0 ± 0.0 c	0.0 ± 0.0 c	100 ± 0.0 a
Marcory	50.0 ± 4.7 ab	0.0 ± 0.0 bc	0.0 ± 0.0 b	50.0 ± 12.6 ac
Treichville	0.0 ± 0.0 c	0.0 ± 0.0 c	40.0 ± 2.9 ab	60.0 ± 13.6 ac
Plateau	33.3 ± 6.1 b	9.5 ± 2.1 bc	0.0 ± 0.0 bc	57.1 ± 8.1 ac
Cocody	0.0 ± 0.0 c	9.1 ± 1.4 b	0.0 ± 0.0 bc	82.7 ± 4.0 ab
Koumassi	67.9 ± 7.6 a	10.7 ± 2.0 bc	0.0 ± 0.0 be	21.4 ± 5.2 be

Means with the same letter superscript on the same line or column are not significantly different ($P < 0.05$)
± means standard deviation

Abidjan, a lettuce seller can make a benefit between 0.87 and 2.93 € per day and between 22.62 and 76.18 € per month (about 26 working days). This situation could be explained by the fact that approximately 12% of the women are of vulnerable strata of the population, therefore, women are heads of some households by the lack of jobs for men and also by socio-cultural habits. This division differs from one geographical region to another. In Côte d'Ivoire, women dominate the marketing of vegetables. However, men (83 to 93%) are responsible for its production (Ogbodo *et al.* 2010; Koffi-Nevry *et al.* 2012). According to Dieye (2006), this informal activity often appears as a response to food security of urban populations, creating jobs for the vulnerable population. These women are not organized into formal associations or cooperatives. They work individually or as family units (Modi *et al.* 2006). This observation is in agreement with that of Koffi-Nevry and Koussémon (2012) about activities such as fish fermentation and also those of Koffi-Nevry *et al.* (2012) on the production of lettuce. Indeed these authors reported that such activities are often informal but could contribute to the food security of an urban population.

The immediate surrounding environment in which lettuce is sold is generally unhygienic, paving the way for possible microbial contamination and evolution of food toxicants, as indicated by Anihouvi *et al.* (2006). The ways in which vegetables are exposed during the selling period represent a key factor in the spread of many communicable diseases. Indeed, vegetables are mostly exposed to the air and sold on stalls or on plastic bags (polystyrene) on the floor most of the time without protection (Table 4). Sellers, equipment (stalls, plastic bags, baskets, etc.) used for sale, water, dirty floors not properly cleaned, dirty clothing and hands of personnel and lettuce are of low hygienic standards at the artisanal level of lettuce handling. Moreover, these vegetables which are the destination of flies from these surrounding pollution sites (Mouli *et al.* 2005) are most often sold not far from mud, close to several sources of contamination such as sewers, public toilets, garbage dumps or open channels. Therefore, the sales site can be considered as a potential risk factor for microbial contamination of food. During the sale, some women regularly sprinkle the lettuce with water from public restrooms of the markets; this could represent a potential risk factor for the spread of pathogens into food (Cissé 1997) and indicates that the sale of the lettuce in unsanitary conditions can affect the sanitary quality of the green leafy vegetable. This behavior may be attributed to a lack of education and facilities, services, sale standards and a lack of economic support from the quality products' market (to offer products of acceptable hygienic quality). The lack of hygiene related to the level of education could explain their ignorance of the impact of the lack of good hygiene practices on the quality of food products for human consumption (Amoah *et al.* 2007).

These results are in agreement with a study conducted by Koffi-Nevry *et al.* (2011) that revealed that samples of lettuce sold on the market were more contaminated with Enterobacteria than lettuce samples from production sites. These authors attributed the contamination of the lettuce sold to the market to the non-compliance with hygiene rules by traders. It should be noted that, in general, markets face a real unsanitary problem related to the lack of adequate facilities.

In addition, the influx of people in the markets could be a risk factor and increase the level of contamination of food sold to the market. Sackou *et al.* (2006) reported that 75% of lettuce samples collected from markets in Abidjan does not meet the criteria set up in microbiology for vegetables. According to the same authors, 44% of the consumers in Abidjan do not use any disinfectant to wash raw edible vegetables. In a recent study, Koffi-Nevry *et al.* (2011) identified some bacteria responsible for food poisoning (*Salmonella gallinarum*, *Shigella sonnei*, *Salmonella choleraesuis*, among others) that may affect consumer health in

samples of lettuce sold in Abidjan markets. This agreed with the results of the work of Sagoo *et al.* (2003) and also of Olsen (2006), who, after having isolated *Salmonella* and *Listeria* in vegetable salads, reported that the conditions under which the production, harvesting, handling and sale of vegetables are done can greatly increase the potential for microbiological contamination. Results of this work are in accordance with those by Amoah *et al.* (2007), who revealed that the contamination of lettuce with pathogenic microorganisms was greater after harvest and marketing. Places of conservation influence the quality of lettuce sold in the markets of Abidjan. Risks related to pathogens and reduction of the hygienic quality of lettuce may increase if proper temperatures are not maintained.

CONCLUSION

Côte d'Ivoire as in most developing countries, vegetables sold to the public in open markets is exposed to the air except those sold in supermarkets. It appears from this study that the improper handling and improper hygiene might lead to the contamination of fresh lettuce and this might eventually affect the health of the consumers. Some diseases could spread and acquire epidemic status which poses serious health hazards. It is therefore suggested to investigate and conduct awareness and training of food shopping on the harmful effects of lack of personal and environmental hygiene, and food safety. The sellers should observe good selling practices and strict hygienic measures so that they may not serve as source of chance inoculation of microorganisms, the water used for washing the lettuce should be of good quality, also the equipment should be clean. Lettuce to be used for consumption purposes should be adequately disinfected before use to prevent contamination of vegetable eaten raw.

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Appendix: Questionnaire for a health audit on the sale of vegetables in the markets

I - Identification

- 1- Name of seller
- 2- Name of market
- 3- Commune
- 4- Date of visit
- 5- Name of interviewer
- 6- Origin of the vegetables (commune)

II - Description of the place of sale

- 1- Hygienic conditions of work equipments (table, benches, utensils, environment, etc.)
Hygienic/Unhealthy (assessed visually)
- 2- Environmental situation (description)
Hygienic/Unhealthy (assessed visually)
- 3- Location of lettuce display
Near garbage dump/Near public toilets/Near obvious contamination source/Near open channels
- 4- Type of vegetables sold
- 5- Type of business, i.e., categories of vendors: Wholesalers/retailers

III- Behavior of sellers at the point of sale

- 1- Appearance (dress)
- 2- Handling vegetables and money
- 3- Treatment of the vegetables when at market: Sorting/Washing; Others. Nothing (specify)
- 4- Origin of the water used: Water supply/Well water; Resellers. Other sources (specify)
- 5-Exposure of products sold: On a table/On the floor; Covered/Uncovered; Presentation: whole/sliced
- 6- Storage of vegetables not sold during the day: At the market/nearby/shop/cold room/at home
- 7- Do vegetables undergo treatment to prolong their shelf life? Chemical treatments; Other treatments (specify); No treatment