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Hygienic Quality and Conservation of Market Gardening Products Sold in the City of Korhogo (Northern Côte d'Ivoire)

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Abstract		Original Research Article

Market gardening is an activity commonly practiced in the city of Korhogo. This study made it possible to take stock of this activity with a view to improving it for the benefit of consumers. A survey was therefore conducted among 100 market gardeners in the Kassirimé, Natio-Kobadara, Koko and Téguérré neighborhoods and 100 vendors at the Sinistré and Belle-Ville markets and at the large market. The results showed that the majority of market gardeners and sellers are women who have not been educated, with more than 10 years of experience. The analysis of production sites through the requirements of the GLOBALGAP standard showed non-compliance rates above 90%. The study on market gardening sites and markets using the ISHIKAWA causality diagram made it possible to identify the risk factors and to propose measures for controlling the dangers. The survey showed that vendors use aeration, ventilation, immersion, drying and sprinkling for the preservation of vegetables. Moreover, market gardeners, like sellers, encounter problems in the practice of this activity. These problems are linked to the lack of supervision, access to agricultural credit and pest's attacks.
Keywords: Market gardening, town of Korhogo, Côte d'Ivoire.

INTRODUCTION

The World's growing population is one of the greatest threats to low food availability. Although significant efforts have been made to combat food insecurity, it remains a source of concern and anxiety. Among the causes, there are essentially climatic hazards, demographic pressure and political instability in certain countries (Koffie *et al,* 2016).

Urban and peri-urban agriculture is of a vital importance for food security because of its role in supplying cities with agricultural products (Dongmo *et al,* 2005). It contributes to the integration and poverty reduction of populations from the countryside. In most studies conducted in Africa, market gardening appears to be one of the main components of urban and peri-urban agriculture that is of a capital importance in the economic development of cities. Market gardening is one of the most productive agricultural systems in sub-Saharan Africa (FAO, 2012). Considered as a food sovereignty activity in Côte d'Ivoire, market gardening plays a key role in most nutrition and poverty reduction programs and contributes significantly to family incomes (Husson, 2012).

However, vegetable production in urban and peri-urban areas has some specificities specific to rural agriculture. These are the new market and non-market functions, the complexity of land rights, the heavy use of chemical inputs as well as the need for water control and control of marketing and supply circuits for phytosanitary products of synthesis (Ogouwalé, 2007). The desire to cover the food needs of cities or large urban areas leads market gardeners to resort, on the one hand, to the massive use of chemical products for the control of pests and soil fertility and, on the other hand, to resort to wastewater for crop irrigation (Adétonah *et al*, 2011). However, in recent years, diet quality has become a growing public health concern. Indeed, scientific data concerning the vulnerability of the human body to certain chemical substances used in food production and the resurgence of certain food-related pathologies indicate that exposure to these toxins, even at low levels; can harm human health (Odo, 2012).

According to (Boko, 2014), market gardening is mainly done with the aim of producing sufficient quantities for food. Food quality is not given the same attention. As for the conservation of vegetables, it is very underdeveloped, 20 to 30% of market garden products in Côte d'Ivoire are destroyed from one year to another because of post-harvest losses. Indeed, once harvested, vegetables remain alive and are subject to the phenomena of transpiration, respiration, maturation and other biochemical activities, which result in a deterioration of the quality (Dossou *et al,* 2007). Thus, the quality and conservation of market garden products deserve to be better documented in order to help market gardeners and sellers to properly preserve products and ensure their quality. This study aims to help improve the quality and conservation of market garden products in the city of Korhogo. It will assess the non-compliance of market garden products on the production sites, identify the causes of the poor hygienic quality of market garden products and finally describe their method of conservation on the sales sites.

MATERIALS AND METHODS
1. Area of Study
Located in the north of Côte d'Ivoire (Figure 1), Korhogo city is the capital city of the Savannas District, the Poro Region and the Department. It is extended over an area of 12,640.4 km², between 9°59' North latitude and 6° 49' West Longitude (PRICI, 2016).
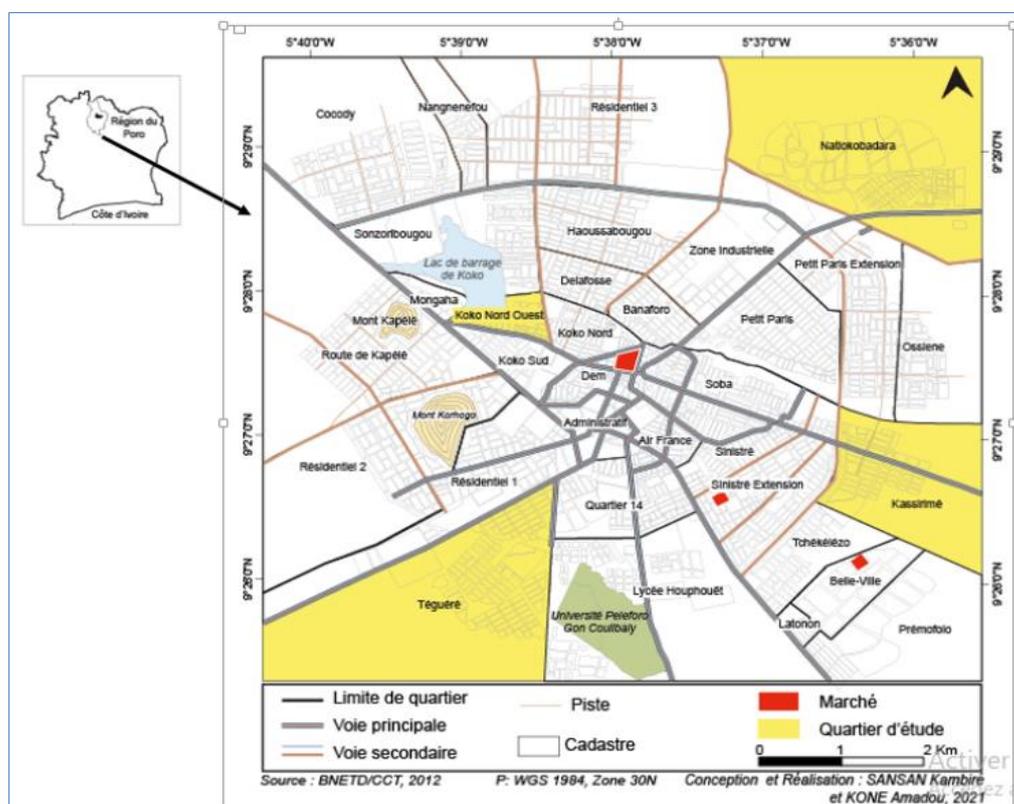

Figure 1: Map of Korhogo city

2. Choice of Survey Sites
The survey sites were first identified based on the work of (Koffie *et al,* 2016), which made it possible to list the main vegetable production areas in Korhogo. These are the sectors of Téguérré, Kassirimé, Koko and Natio-Kobadara. These data were supplemented by a field survey. In total, the study therefore covered 100 producers and 100 sellers (Table I).

Table I: Sites and number of people surveyed

	Sites	Numbers
Producers	Kassirimé	12
	Natio-Kobadara	17
	Koko	42
	Téguérré	29
Sellers	Large Market	33
	Sinistré Market	43
	Belleville Market	24

3. Sampling Method

The survey took place from September 20th 2021 to October 23rd 2021. The technique chosen is that assisted by interview, some actors in the target population having a modest level of education. Producers were met at production sites and at home, and vendors at the market. Each actor was submitted to a questionnaire in the form of a direct interview.

The questionnaire addressed to producers and sellers was related to their socio-demographic profile. Then, the first were questioned about their farming practices, including the use of phytosanitary products, health and environmental risks and marketing. In addition, both groups of actors provided information on how vegetables are stored and preserved.

4. Data Analysis

The information collected during the survey focused on compliance or non-compliance with the standards (requirements and recommendations) of the GLOBALGAP standard point by point. All points observed that do not comply with the requirements (major, minor and recommendations) of the GLOBALGAP standard have been recorded. For each site visited, the percentages were calculated by multiplying the total number of non-compliant requirements (major or minor) by 100 and compared to the total number of requirements (major or minor) of the GLOBALGAP standard (Kouakou, 2019) The same was true for the recommendations. Non-conformities are minor or major requirements that have been poorly applied by the producers in relation to the GLOBALGAP requirements.

Also, the information collected made it possible to identify, by family, all the possible causes that could influence the quality of market garden products. This classification was made based on the 5M (Environment, Product, Material, Labor and Method). Finally, the description of the preservation methods was made from the answers given by the sellers on their vegetable preservation technique.

RESULTS
1. Sociological Profile of Vegetable Producers and Sellers

The producers (96%) and sellers (99%) are mostly women. In addition, they are rather illiterate (93% of producers and 84% of sellers), 5% of producers having a primary level and 2% a secondary level against 6% and 10% respectively among sellers. Finally, with regard to the number of years of experience, actors with more than 10 years of experience are the most numerous (88% producers and 80% sellers).

2. Assessment of Non-Compliance with GLOBALGAP Standard Requirements
2.1. Non-Compliance of Market Gardening Sites with Major and Minor Requirements

The study showed high non-compliance rates for major and minor requirements (Table II), all above 90%. Those recorded in Koko and Téguérré are 91.29% at the major and minor level. The sites of Kassirimé and Natio-Kobadara have percentages of 94.56% and 95.58% at the major level against 79.26 and 81.06% at the minor level, respectively.

Table II: Rate of non-compliance with major and minor requirements: FV: Module applicable to all farms; CB: Empty containers of plant protection products; AF: fruits and vegetables

Sites	Points of the benchmark with major requirements				Points of the benchmark with minor requirements			
	FV	CB	AF	(%)	FV	CB	AF	(%)
Koko	35.86	25.00	30.43	91.29	9.00	54.95	17.11	91.29
Téguérré	35.86	25.00	30.43	91.29	9.00	54.95	17.11	91.29
Natio-Kobadara	36.95	26.08	32.60	95.58	9.00	54.95	17.11	81.06
Kassirimé	38.04	25.00	31.52	94.56	9.00	53.15	17.11	79.26

2.2. Non-Compliance with Recommendations on Market Gardening Sites

The localities of Koko, Téguérré, Kassirimé and Natio-Kobadara have the same rates of non-compliance with the recommendations on the different sites with a percentage of 93.32%.

Table III: Rate of non-compliance with recommendations: FV: Module applicable to all farms; CB: Empty containers of plant protection products; AF: fruits and vegetables.

Sites	Reference points			
	FV	CB	AF	Percentage (%)
Koko	13,33	33,33	46,66	93,32
Téguérré	20,00	26,66	46,66	93,32
Natio-Kobadara	20,00	26,66	46,66	93,32
Kassirimé	13,33	26,66	46,66	93,32

2.3. Identification of the Causes of the Poor Hygienic Quality of Market Garden Products
2.3.1. Treatments against Pests and Fertilizer Application
The study reveals that 6% of market gardeners do the treatment once a fortnight, the majority (88%) every week and 6% of them every 2 to 3 days.

2.3.2. Sources of Irrigation Water
More than half of the producers (57%) use dam and well water against 22% only well water. The least numerous use water from ponds (11%), and 10% for rainwater and lowlands (5% for each of these water sources).

2.3.3. Pest Control and Fertilization
All market gardeners use manual weeding and mixing (NPK 15 15 15) and Urea for fertilizing plots. All also use chemical insecticides for pest control.

2.4. Classification of the Causes of Poor Hygienic Quality of Market Garden Products
Figure 2 presents the main causes of non-satisfaction with the general principles of hygiene through the realization of the Ishikawa diagram. The workforce is essentially illiterate with no supervision or training. Also, the wearing of personal protective equipment is not respected. Regarding the environment,

the study reveals garbage and wastewater in contact with vegetables and degraded soils. The fertilizers used are those indicated for cotton growing. Finally, many vegetables are injured during harvesting and handling. The analysis of the cultivation method reveals a bad practice of irrigation and fertilization. The quantities of water as well as the doses of fertilizers and phytosanitary products are not controlled. Chemicals are used without hand protection. Finally, the harvesting equipment used is either unsuitable or not disinfected. Manual harvesting is also done without protective measures (disinfection).

2.5. Description of Vegetable Preservation Methods
Vegetables are mostly kept (64%) on the tables at the market and secondarily in the store (18%) or at home 18%. The materials used for the preservation of vegetables are bags, sachets, boxes, bowls, baskets and boxes. Also, it should be noted that when the method of phytosanitary treatment is respected, the vegetables keep longer, even less in the opposite case. The majority of sellers (92%) justify the post-harvest losses attributable to non-compliance with phytosanitary treatments against 5%, 2%, 1% of them who rather think that these losses are due respectively to heat, rain and injury during harvesting and handling. In terms of preservation techniques, vendors preferentially use (92%) the product aeration method, against only 4% spraying, 1% ventilation and drying and 2% immersion.
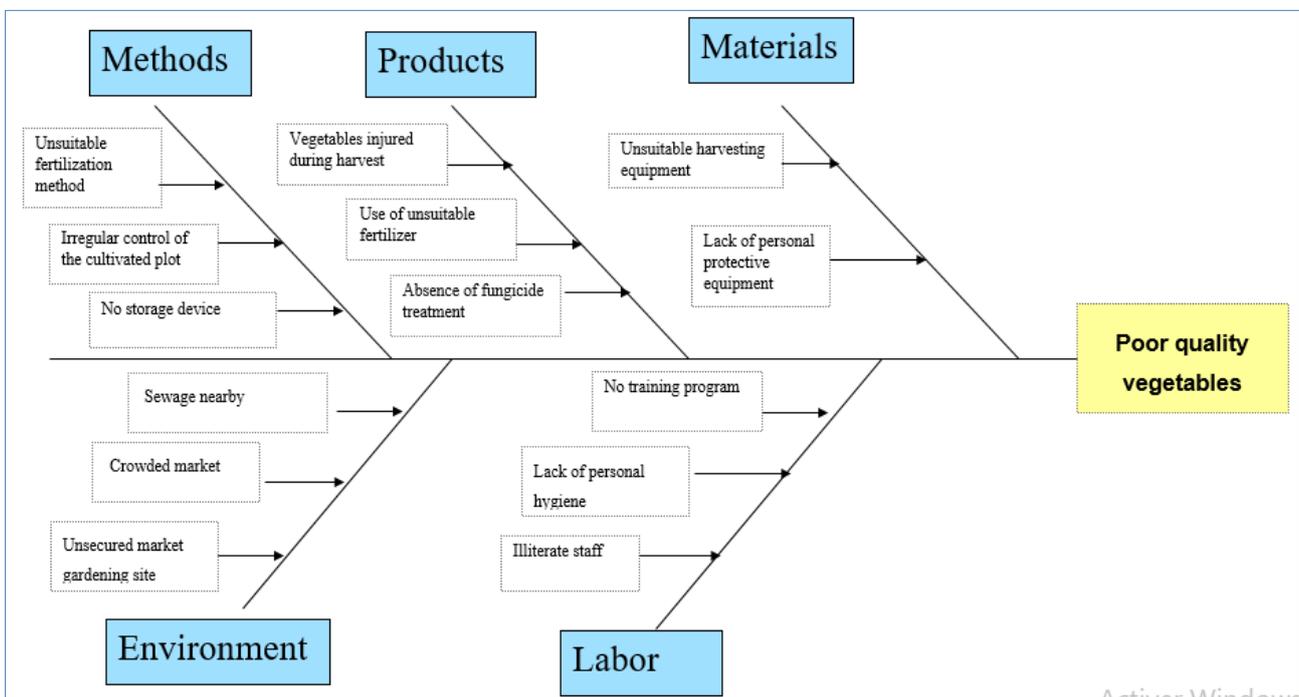

Figure 2: Ishikawa cause-effect diagram for poor product quality

Figure 3: Photographs of the crop environment: a, b, c and d: garbage near the plots in Koko; e, f and g: garbage in contact with vegetables in Koko; h, i, j and k: irrigation water at Natio- Kobadara; l, m and n: unprotected plots in Koko.

Table IV: Material and shelf life of vegetables

Organs consumed	Common name (Scientific name)	Standards not respected	Standards respected	Preservation material
Fruits	Tomato (*Solanum lycopersicum*)	1 à 4 days	1 à 2 weeks	Carton
	Eggplant (*Solanum melongena*)	1 à 5 days	1 à 4 weeks	Bag
	Pepper (*Capsicum frutescens*)	1 à 3 days	1 à 3 weeks	Bag
	Bell pepper (*Capsicum annuum*)	1 day	3 days	Bag
	Cucumber (*Cucumus stivus*)	1 à 3 days	1 à 4 weeks	Bag
	Melon (*Cucumus melo*)	1 day	3 days	Bag
	Watermelon (*Colocynthis citrullus*)	1 à 4 days	1 à 2 weeks	Bag
	Zucchini (*Cucurbita pepo*)	1 à 4 days	1 à 2 weeks	Bag
	Squash (*Cucurbita moschata*)	1 à 5 days	1 à 4 weeks	Bag
	Okra (*Abelmoschus esculentus*)	1 à 3 days	1 week	Box
	Green bean (*Phaseolus vulgaris*)	1 à 3 days	2 weeks	Basin
	Gnangnan (*Solanum nigrum*)	1 à 2 days	2 à 3 days	Basin
	Leaves Cabbage (*Brassica oleracea*)	1 à 3 days	1 à 4 weeks	Basin
	Mint (*Mentha spicata*)	1 day	3 days	Basin
	Parsley (*Petroselinum crispum*)	1 day	1 à 3 days	Basin
	Celery (*Levisticum officinale*)	1 day	1 à 3 days	Basin
	Spinach (*Spinacia oleracea*)	1 day	2 days	Basin
	Lettuce (*Lactuca sativa*)	1 day	1 à 2 days	Basin

Organs consumed	Common name (Scientific name)	Standards not respected	Standards respected	Preservation material
Leaves	Dah (*Hibicus sabdariffa*)	1 day	1 à 3 days	Basin
	Kplala (*Corchorus olitorius*)	1 day	3 days	Basin
	Bonombrou (*Amaranthus hibridus*)	1 day	3 days	Basin
Roots	Roots Turnip (*Brassica napus*)	1 à 5 days	1 à 2 weeks	Bag
	Carrot (*Daucus carota*)	1 à 5 days	1 à 3 weeks	sachet
Tubers	Tubers Potato (*Solanum tuberosum*)	1 week	1 à 3 months	Bag
	Sweet potato (*Ipomoea batatas*)	1 week	1 à 3 weeks	Bag
Bulbs	Bulbs Onion (*Allium cepa*)	1 week	1 à 3 months	Bag
	Garlic (*Allium sativum*)	1 week	1 à 3 months	Bag

DISCUSSION

This study reveals that the sectors of production and marketing of market gardening products in the city of Korhogo are mainly dominated by women who have not been educated. Although agriculture is the main activity practiced in this locality, men particularly seem to consider market gardening as a female activity. Hence the strong representation of women in this sector. As these women do not benefit from schooling, the children are then interested from an early age in farming practices, which would justify the high number of their years of experience. (Kouakou, 2019) also reports that market gardeners learn cultivation techniques from an early age. At the marketing level, (Koffi *et al,* 2012) and (Drechsel *et al,* 2014) believe that tasks such as selling vegetables requiring less physical effort are the most dedicated to women. During this study, a total of 27 market garden products including fruits, leaves, roots, tubers and bulbs were identified.

The non-schooling of the vast majority of producers has consequences on poor farming practices, on product conservation methods and the way in which products are marketed. It could also be associated with the lack of training they should have had. In fact, 88% of producers carry out phytosanitary treatment with insecticides every week, whereas it is recommended to observe a minimum period of fifteen days between two consecutive applications of pesticides. There is therefore an excessive use of these products. All producers use chemical pesticides including insecticides, NPK 15 15 15+ Urea and purely manual weeding. This situation highlights the presence of crop pests in the fields but also poor soils. The strong presence of pests was also reported by (Bassolé *et al,* 2007) in urban and peri-urban market gardening in Burkina Faso with the presence of biting, sucking and crushing insects, defoliating caterpillars and root-knot nematodes. In addition, nearly 80% of producers use water from dams and wells to irrigate vegetables. This is the consequence of the use of the edges of dam lakes to practice this activity. However, the use of shallow artificial wells can promote the biocontamination of vegetables. Indeed, the contact of vegetables with contaminated irrigation water could contribute to their contamination. Previous studies, carried out in Korhogo, have shown that the irrigation water used by market gardeners contains pathogens that can persist in these environments and be transmitted to the products (Ollo *et al,* 2021).

After harvest, the vegetables are mainly packaged in fiber bags which do not fully protect them from external contamination. Some authors have noted the risk of biocontamination associated with this packaging method (Cofie *et al,* 2009). Toé (2018) has also highlighted this reality in his study on the risk factors for biocontamination by virulent *Salmonella* and *Escherichia coli* in the vegetable food chain in Abidjan. All these factors are likely to negatively impact the hygienic quality of food products intended for human consumption. In addition, the preservation methods used are aeration, ventilation, immersion, drying and sprinkling, which are considered traditional. All of these observations point to a low level of funding in this sector.

The GLOBALGAP standard indicates that the rates of non-compliance with the requirements criteria of the GLOBALGAP standard for sites are very high on the basis of major and minor requirements and recommendations. Regarding major requirements and minor requirements, all production sites have a non-compliance rate of over 90%. This could be explained by the fact that market gardeners have no knowledge of the existence of the GLOBALGAP standard. These results are in agreement with that of (Kouakou, 2019). According to this author, the rise in non- compliance rates is due to the lack of information and training of producers. As for the recommendations, the rates are all the same 93.32%. These results are similar to those of (Kouakou, 2019) who had rates of 80%.

CONCLUSION

The production and marketing of market garden products in the city of Korhogo are mainly practiced by women who have not been to school. This low level of education has an impact on farming techniques and product conservation. The analysis of the sites of

Production through the requirements of the GLOBALGAP standard showed non-compliance rates above 90%. The study on market gardening sites and markets using the ISHIKAWA causality diagram made it possible to identify the risk factors. Preservation

methods boil down to aeration, ventilation, immersion, drying and spraying products. In addition, the study highlighted problems related to insufficient supervision, access to agricultural credit and pest attacks.

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