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Assessing the health and environmental risks of phytosanitary practices used by market gardening in the Yaounde 7 area (Nkolbisson) in Cameroon

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ABSTACT

The aim of this study was to assess the health and environmental risks associated with the use of phytosanitary products in market gardening in Yaoundé 7 area (Nkolbisson), Centre region of Cameroon. A survey was conducted among 40 market gardeners and 6 samples of water collected from rivers, wells and boreholes were analyzed in the laboratory to measure the residues of pesticides, using the Gas Chromatography technique (GC). The results showed that insecticides and fungicides were the most phytosanitary products used by smallholder farmers to supply local markets with vegetable and other foodstuffs; in addition, to these intensive use of insecticides and fungicides, it has been observed that involving market gardeners conducts their activities without using any suitable Personal Protective Equipment (PPE) such as respiratory masks, gloves and adapted clothes. Cumulative results show that around 80% of respondents do not wear masks or mufflers (57.5%), and adapted clothing (98%) during the application of phytosanitary products. The direct consequence of these bad practices is recurrent health problems affecting producers like itching (82.5%), headache (75%), frequent sneezing (52.5%), dizziness (22.5%) and vomiting (17.5%). Empty phytosanitary packages were usually abandoned in farms (67.5%) and incineration (25%) was the preferred method of discarding these empty packages. Water analysis revealed a concentration of 13.74 g/L of metalaxyl, an antifungal active substance in one river water and a small quantity of cypermethrin in a trace. This concentration greatly exceeds the WHO guidance value (0.05 µg/L), which discredited the uses of this water in consumption. Based on the above results, these inappropriate practices expose these smallholder farmers and consumers to high health risks and also contribute to environmental degradation.

Keywords: Risk, health, environment, phytosanitary products, market gardening, Nkolbisson.

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INTRODUCTION

Market gardening is the commercial production of high-value crops such as vegetables, fruits, flowers and other plants on a scale, larger than a home garden. In Africa, market gardening employs 40% of the urban population and contributes 20 to 30% of the Gross Domestic Product (Tchamadeu et al., 2017). In Cameroon, market gardening in urban areas contributes to food security and is an important source of employment and income. Yaoundé is one of the cities of Cameroon where intense market gardening activity is performed. Due to numerous constraints that face the activity, such as parasites, phanerogam and pest pressure, market gardeners are excessive used phytosanitary products (e.g., fungicides, herbicides, insecticides) to increase their yields (Mondédji

et al., 2015; Yarou et al., 2017; Soro et al., 2018). However, these phytosanitary products present a range of negative side effects such as environmental pollution and detrimental health effects for market gardeners and consumers. That is a concern, as many studies have shown it. Soro et al. (2019) study on the application of phytosanitary products in market gardening in Ivory Coast has shown that the inadequate practices in horticulture are the main factors for health and environmental risks, for producers and consumers and the natural resources (e.g., air, water, soil and biodiversity) qualities. Similarly, the work of Ahouangninou et al. (2011), has shown that the excessive use of phytosanitary products by market gardeners in Benin increased their health risks as well as those of the consumers.

The environmental protection, safety of fresh fruits or vegetables and health of urban smallholder farmers regarding the use of phytosanitary products are still major concerns for the development of market gardening activities (Bella, 2014). The lack of adequate control in gardening in Cameroon and particularly in Yaoundé, the anarchic use of phytosanitary products might be a threat to the health of market gardeners and consumers but also for the environmental sustainability (Bella, 2014). To have some information on the status of phytosanitary products and to contribute to the best utilization of gardening in Yaoundé, it is useful to have a diagnosis of utilization conditions as well as environmental and sanitary risks related to the handling of these products. The objective of this study is to assess phytosanitary product levels in the market gardening in Nkolbisson (Yaoundé), furthermore to evaluate the environmental health risks on producers and consumers.

MATERIALS AND METHODS

Study site

The study site was Nkolbisson area, located in Yaoundé VII subdivision, Mfoundi division, Centre region, Cameroon (Figure 1). This site possesses numerous market gardening where several vegetables such as cabbage, lettuce, pepper, tomato, cucumber, etc, are cultivated. The study site is characterized by a humid and dry tropical climate, with variable temperatures throughout the year. It has a length humid season, covering ten-span between March and November. However, there is a noticeable decrease in precipitation within the rainy season, seen during July and August, almost giving the city appearance of having two separate rainy seasons. This decrease in rainfall is surely linked to the fast growth of urbanization of the Yaoundé city, and the drastic reduction of vegetation for housing. The vegetation is inter-tropical with the predominant southern rainforest. This study site watershed is part of the Mefou which drains part of the city of Yaoundé. The hydrographic network is marked by the Mfoundi River, fed by numerous streams. The population of Nkolbisson is composed of students, farmers, traders; there are also civil servants and craftsmen.

Sample collection and preparation

A sampling campaign was carried out in August 2020. Six (6) water points including three (3) surface water points and three (3) underground water points were collected. These water points were chosen according to their accessibility and proximity of the plots to water sources used for watering crops. The surface water (river) was located in cultivated areas and underground water (wells and boreholes) were located at 300 m from the farms. These wells and boreholes are used by the populations for their consumption. The average depth of wells is approximately 5 m and that of boreholes 60 m in the area. Sterilized polyethylene vials with covers having a capacity of 1 liter were filled with water and transported to the laboratory where they were stored in the freezer at the temperature of 4°C for upcoming analysis.

Heath and environmental risks assessment

A survey was carried out among 40 market gardeners who own the plot. The choice of surveys was made randomly involving volunteers present on the identified production sites. Questions were asked about the socio-economic characteristics of market gardeners, the different phytosanitary products used and the sources of supply, the environmental perception and health problems they suffer as a result of the use of phytosanitary products.

Water analyses

Active compounds of insecticides and fungicides used by these marker gardeners were identified using Gas chromatography technique (An and Shin, 2011). This technique is based on the separation of chemical components of a mixture according to their retention time and their affinity for the stationary phase. The following procedure was put in place during the water analysis:

Step 1 extraction phase: 10 ml of each sample was measured then 15 ml of 1% acetic acid in acetonitrile, 6.5 g of magnesium sulphate and 2.25 g of sodium acetate added to the samples with a ceramic homogenizer which facilitated the mixture of the solution. The mixture was vortex for 1 min and then centrifuge at 4500 rpm. After centrifugation, there was complete separation of phases; semi-solid, aqueous middle, and the organic supernatant (containing the pesticides).

Step 2 clean up phase: This consists of extracting 8 ml of the separated solution in the centrifuge tube containing 1.2 g of magnesium sulphate, 0.3 g of a primary-secondary amine and ceramic homogenizer to facilitate the mixture. The primary and secondary amines help to remove all the organic elements found in the samples. The mixture was vortex for 1min then centrifuge at 4500 rpm for 1 min.

Step 3 analysis phase: To assess the result, a software called chem station gets the result from the mass spectrometer detector and translates it into specific names. It gives the exact name of any component that has been detected, (An and Shin, 2011).

Data analysis

Data obtained from the survey were analyzed using the software Epi data version 7.2.3.1 and an Excel spreadsheet (2013) was used to encode data. Data of GC analysis were analyzed using Chem

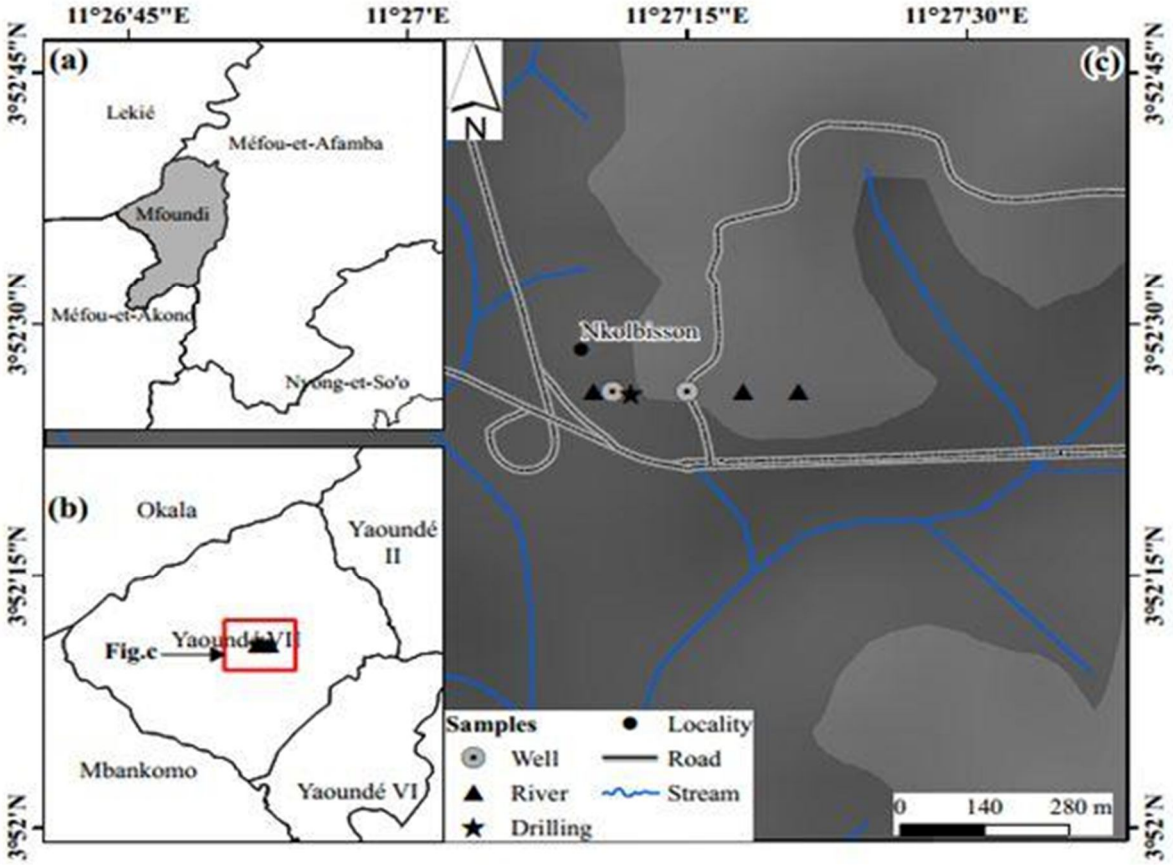

Figure 1. Map of location and sampling.

Station software.

RESULTS

Socio-economic characteristics of market gardeners

Gender and level of instruction of market gardeners are the socio-economic characteristics studied in this area.

Sex of market gardeners

The results of the survey revealed that among the 40 market gardeners interviewed, 37 (92.5%) are men and only 3 (7.5%) are women (Figure 2).

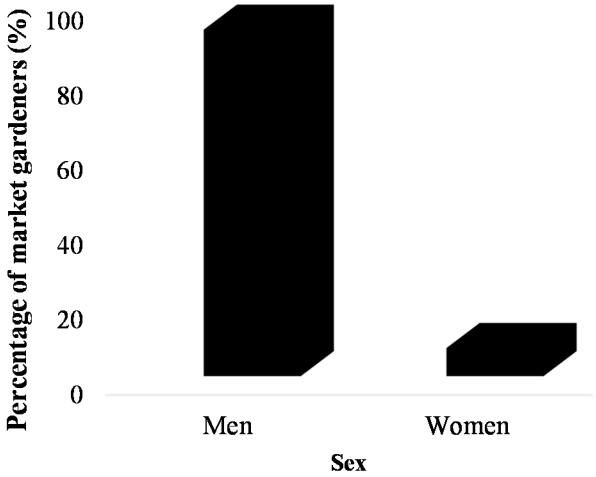

Figure 2. Sex of market gardeners.

Level of instruction of market gardeners

The level of instruction of market gardeners is high, around 95% went to school. Among them, 62.5% went to primary school, 27.78% reached secondary school, 5% higher cycle and 5% illiterates (Figure 3).

Phytosanitary practices of market gardeners

Phytosanitary products used by market gardeners

The results of the survey revealed the use of 8 active

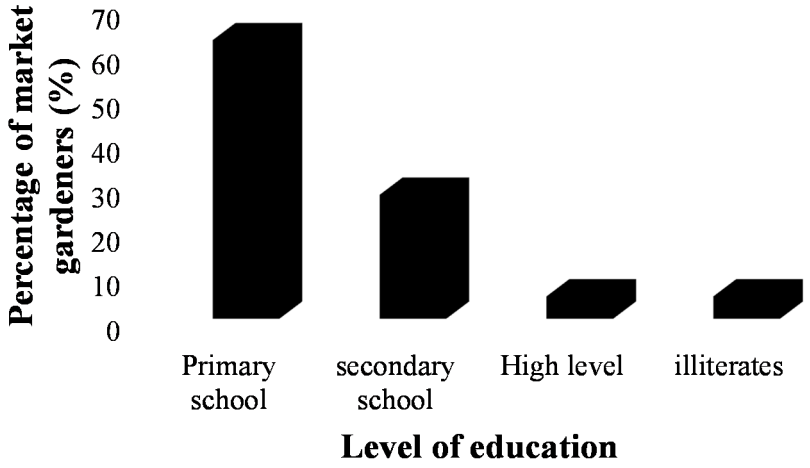

Figure 3. Level of education of market gardeners.

substances that are cypermethrin mancozebe, emamectin benzoate, chlorpyfifos ethyl, metalaxyl, sulphur copper oxychloride, lambda cyhalothrin, chlorothanlonil carbendazine. The phytosanitary products apply on crops belong to two major chemical families which are pyrethroid (insecticides) and dithiocarbamate (fungicides). Insecticides (57.14%) and fungicides (42.86%) are the most phytosanitary products used by market gardeners. Insecticides are applied 1 time per week to fight against insect attacks. As for fungicides, they are applied twice a month. The lists of the different phytosanitary products used by market gardeners and their active compounds and concentrations are represented in Table 1. Fourteen (14) commercial names of phytosanitary products have been listed divided into two categories and families which are pyrethroid and dithiocarbamate (Table 1).

Management of empty packages of sanitary products

Concerning management of empty packages after usage of phytosanitary products, 65% of the empty packages are abandoned in the farms, 25% are incinerated and 10% are used for other purposes such as domestic usage (Figure 4).

Table 1. Phytosanitary products used by market gardeners in the Nkolbisson area.

Commercial names	Active compounds and concentrations	Categories	Families
Cypercal 100 EC	Cypermetrin 100 g/L	Insecticide	Pyrethroid
Mamira super 90 EC	Lambda cyhalothrine 90 g/L	Insecticide	Pyrethroid
Cygogne 360 EC	Cypermethrin 360 g/L	Insecticide	Pyrethroid
Emacot 50 WG	Emamectine benzoate 50 g/L	Insecticide	/
Cypercal 720 EC	Cypermethrin 720 g/L	Insecticide	Pyrethroid
Grosplant 480 EC	Chlorpyrifos-ethyl 480 g/L	Insecticide	Organophosphate
Pacha	Lambda-cyhalothrine, acetamipride	Insecticide	Pyrethroid
Cypalm 200	Cypermethrin 200 g/L	Insecticide	Pyrethroid
Banko+	Chlorothalonil 550g/l, carbendazine 100 g/L	Fungicide	/
Mon champ 72 WP	Mancozeb 60%, metalaxyl 12%	Fungicide	Dithiocarbamate
Penncozeb 80 WP	Mancozeb	Fungicide	Dithiocarbamate
Mancozeb	Mancozeb	Fungicide	Dithiocarbamate
Curly plant	Sulphur 60.8%, copper oxychloride	Fungicide	/
Metro star 500 WP	Thiplanate-methyl 150 g/kg, cupper oxychloride 200 g/kg, sulphur 150 g/kg	Fungicide	Dithiocarbamate

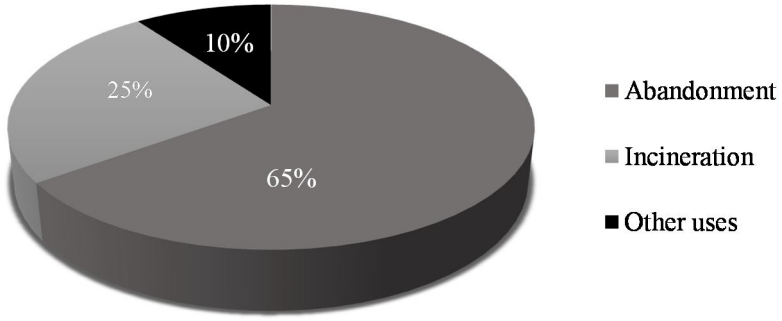

Figure 4. Management of empty packages of phytosanitary products by market gardeners.

Potential risks of phytosanitary products for the health and environment

The potential risk for health

The results of the survey show that the majority of market gardeners do not take any precautions during phytosanitary activities. They apply phytosanitary products without using any Personal Protective Equipment (PPE) and are frequently facing health problems. When treating their plots, 80% do not wear gloves, 57.5% of them do not have a nose mask, and when spreading 97% do not wear special clothes. Regarding the various pathologies which market gardeners suffer, the survey indicates that 75% have headaches, sneeze 52.5%. We equally noticed that 22.5% suffer from dizziness, itches 82.5% and frequent vomiting 17.5%.

Identification and quantification analysis of phytosanitary product residues in water samples

The result of the GC analysis reveals the presence of metalaxyl residue in surface water (river) that appeared after 3.95 min. The concentration of metalaxyl found is 13.74 g/L. The chromatographic peak of metalaxyl is represented in Figure 5.

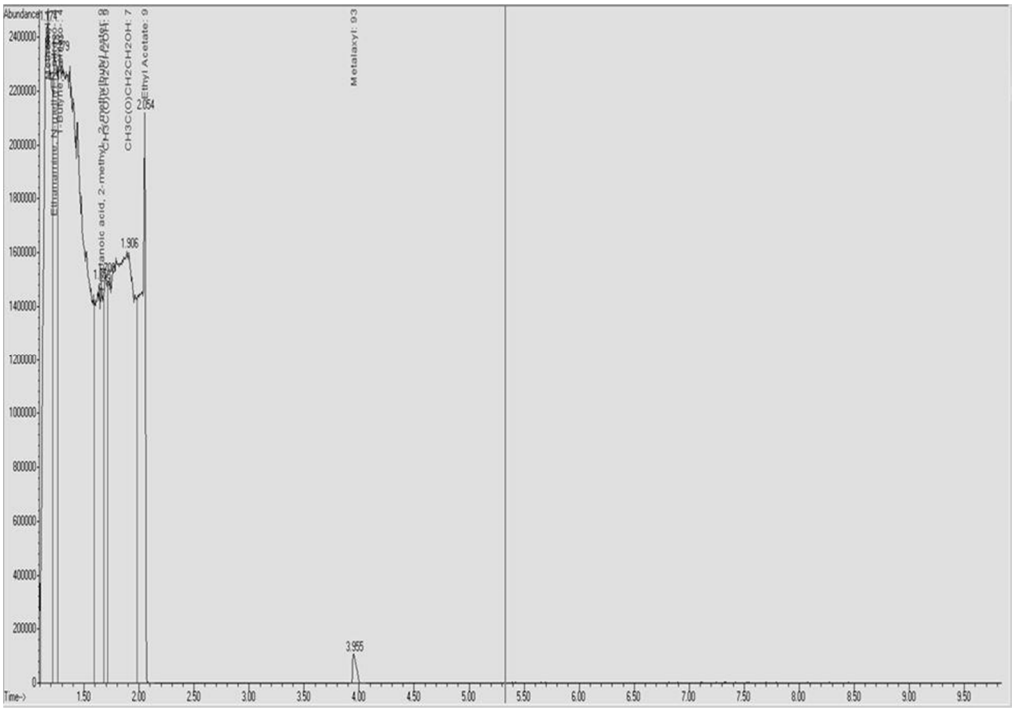

Figure 5. The chromatographic peak of metalaxyl.

DISCUSSION

The market gardening in the Nkolbisson area is mainly practiced by men. Similar results have been obtained by Muliele et al. (2017) in market gardening in the Kongo central area (Democratic Republic of Congo) where the market gardening activities were mainly practiced by men. In this study, the low proportion of women in market gardening can be explained by the inability of women to apply phytosanitary products in the market gardening activities. Indeed, phytosanitary treatment is a hard work task (to get the product, prepare the solution and apply) and complicated for those who are not trained like most women working in market gardening. On the other hand, the results of the survey showed that more market gardeners (95%) are literates. This result shows that market gardening can be an activity that provides employment and generate income in the Nkolbisson area. This result is different from those obtained by Mawussi et al. (2014) in Togo, where market gardening was most practiced by illiterates.

The results of the survey revealed that phytosanitary products are applied to protect crops from insects and fungi. Then, insecticides are the most frequently used (59%), followed by fungicides (41%). Similar results have been obtained by Soro et al. (2019) in market gardening in the Azaguié area (Ivory Coast) which reported that insecticides were the most used phytosanitary products by growers following by fungicides. However, during phytosanitary treatments, market gardeners use phytosanitary products without any Personal Protection Equipment which can justify the presence of diseases such as headache, sneezing and skin diseases. The number of market gardeners who comply with hygiene rules is very low. These results are in accordance with those reported by Mawussi et al. (2014) in Togo where a survey has shown that 98% of producers do not comply with hygiene rules during and after phytosanitary treatments. Similarly, research of Williamson et al. (2008) has shown that the cases of hospitalizations (due to lack of respect of hygiene measures during the spreading of phytosanitary products) have been noticed among market gardeners in Ethiopia and Ghana.

The majority of market gardeners went to school contrary to what one might think. The misuse of phytosanitary products comes from a lack of training. The level of instruction does not present an environmental risk. These results are different from those obtained by Soro et al. (2018) which reported that the high rate of illiteracy could constitute an obstacle to a good knowledge of the condition of use of phytosanitary products.

Observation revealed that after the use of phytosanitary products, most empty packages were thrown away in farms by market gardeners (65%), some were incinerated (25%) and others (10%) were used for purposes such as domestic usage. Most of the time, the empty packages of phytosanitary products thrown end up in water points and pollute the aquatic ecosystem and environment. Abandoned empty packages in farms do not only contaminate the water bed but also degrades the landscape aesthetic. Son et al. (2017) in Burkina Faso have also shown that 53% of market gardeners abandon empty packages of phytosanitary products in farms after treatments.

Cypermethrin, which is a phytosanitary product belonging to the family of pyrethroid and the most active compounds of phytosanitary products used by market gardeners, was not present in water samples. This result can be explained by the fact that cypermethrin is a substance that can rapidly degrade under light exposure and water samples were not stored in dark containers to avoid light degradation. This is probably one of the reasons why it was not found in water. Metalaxyl which is an antifungal belonging to the family of carbamate was found in a surface water sample (river). The average content of metalaxyl recorded in river water is 13.9 g/L. This concentration greatly exceeds the WHO guidance value (WHO, 1997), consequently, this water qualifies as unsuitable for a direct source of drinking water. These results can be firstly explained by the proximity of market gardening with the sources of water. Gomgnimbou et al. (2009), demonstrated that the proximity of market gardening with sources of water constitutes a major risk of contamination. Secondly, this result can be explained by the fact that during rain, an important quantity of phytosanitary residues is transported by runoff or leaching and end up in rivers. That contributes to destroy the aquatic resources present in rivers and also create water pollution. Pesticides residues were detected in different fish species in river Oueme in Benin (Pazou et al., 2006). These producers' behavior must be corrected to prevent pollution of aquatic ecosystems and to preserve the state of health of the surrounding population. Studies performed in Ivory Coast (Soro et al., 2019), Nigeria (Akan et al., 2013), and Senegal (Ngom et al., 2012) have shown the contamination of surface water by phytosanitary products used in market gardening. Then, this substance detected in surface water could be due to these two physical phenomena.

CONCLUSION

This survey carried out among market gardeners in Yaounde 7 area (Nkolbisson) made it possible to list the phytosanitary products used by them, identify and describe the risks to health and the environment. Phytosanitary practices of market gardeners confronted with parasite and pest pressure are not without consequences on their health, that of consumers, and the environment. Certain pathologies were reported by

market gardeners such as severe headache, sneezing, dizziness occurring during or a few days after the use of phytosanitary products. The abandonment of empty packages of phytosanitary products is a major source of environmental contamination. Exposing producers and consumers to high health risks and also contribute to the degradation of the environment including water resources. To promote sustainable market gardening, the use of plants pesticides by the producers can be an alternative for the use of synthetic pesticides and contribute to protecting the environment and health of producers and consumers.

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