

Analysis, quantification and identification of pesticides from vegetables (lettuce) in Ouagadougou (Burkina Faso)

ABSTRACT

In Burkina Faso, chemical inputs are used massively in market gardening to increase yields. The misuse of these chemicals often causes contamination of market garden products, leading to the rapid rotting of vegetables. The objective of this study was to determine the pesticides in chemical inputs applied on vegetables produced in Ouagadougou City. To do this, some vegetables have been sampled from producers (Tanghin, Boulmiougou and Kossodo) and analyzed.

Chemical analyses have carried out on three lettuce samples, including one sample for each site to determine the amount of chemical input residues contained in each sample. The extraction of chemical input residues was done according to QuEChERS (Quick Easy Cheap Effective Rugged and Safe) method using Gas Chromatography coupled with mass spectrometry (GC / MS). Results revealed the presence of six (06) pesticide molecules (chlordimeform, quintozone, lindane, cypermethrin, α -cypermethrin, δ -deltamethrin) in Boulmiougou sample, four (04) molecules (methomyl, cypermethrin, α -cypermethrin, δ -deltamethrin) in Kossodo sample and three (03) molecules (cypermethrin, α -cypermethrin, δ -deltamethrin) in the Tanghin sample. In this regard, analysis of pesticide amount revealed that the quantity of molecules was acceptable for the consumer, but this does not prevent it from contributing to the rapid rotting of ~~our~~ vegetables which generates economic and social losses ~~for the~~ ~~country~~.

Keywords: Chemical inputs, fertilizers, pesticides, rapid rot, vegetables.

1. INTRODUCTION

In Burkina Faso, agriculture is the main source of income for the poorest populations and the pillar of the country's food security. It contributes approximately 35% to GDP and the market gardening sector generates more than ~~eighty-two (82) billion FCFA annually~~ [1].

However, agriculture in Sub-Saharan African countries is characterized by its low productivity [2]. Indeed, this sector is threatened, in addition to poor soils, by crop pests which can cause a drop in yields of up to 50% in Burkina Faso [3]. Thus, to increase yields and satisfy growing consumer demand, in addition to the use of fertilizers, vegetable producers wage, an incessant fight against insects, fungi, plant diseases, and weeds ~~through the use of using~~ pesticides. Market gardening is a major component of the agricultural

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production sector. This component generates more than eighty-two (82) billion FCFA to the Burkinabè economy annually [1].

However, in addition to poor soil conditions, this sector is faced with biotic stress caused by various pests. These pests, without pesticide treatment, were responsible for 72.5% of damage to cabbage in the towns of Ouagadougou [4, 5]. Thus, to increase yields, maintain healthy crops and satisfy growing consumer demand, in addition to the use of grains, market gardeners wage an incessant fight against insects, weeds, fungi, and plant diseases. cultivation through the use of pesticides. Unfortunately, the majority of market gardeners have no level of education, hence the widespread use of pesticides without respecting good usage practices [6]. In addition, market gardening systems often receive unbalanced and excessive supplies of chemical fertilizers in most African cities.

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In Burkina Faso, the analysis of 46 samples of vegetables taken in Loumbila revealed the presence of pesticide residues in all 46 samples and in 5 samples analyzed that there were more residues than legally authorized by the Codex Alimentarius. A previous study [7] assessed the presence of pesticide residues in 240 vegetable samples collected from shopping centers (supermarkets, grocery stores and markets) in the Greater Accra region (Ghana). The general objective of this work was to contribute to the identification of pesticides resulting from chemical inputs applied in the production of vegetables (lettuce) in the city of Ouagadougou. Specifically, this involved:

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2. MATERIALS AND METHODS

2.1. Presentation of the study area

The study took place in the city of Ouagadougou (12°45'N, 1°15'W), the capital of Burkina Faso. The city is located between 2°00 and 1°15 West Longitude and between 12°45 and 12°00 North Latitude. Thus, the sites selected are the market gardening sites of Boulmiougou, Kossodo and Tanghin. The choice of these sites is was based on the fact that they are part of the main market gardening sites in the city of Ouagadougou, the intensive practice of market gardening activity; of the relatively short distance for transport and the preservation of samples [8].

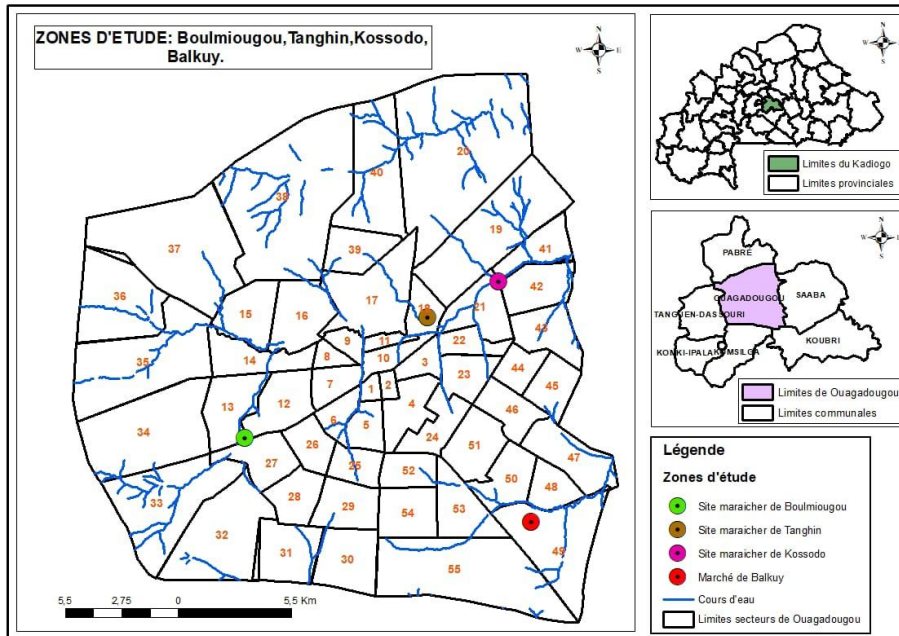


Figure 1 :Map of the study area (IGB /BNDT 2012)

2.2. Plant material

Lettuce (*Lactuca sativa*) As part of our work, the choice is made on was chosen lettuce (*Lactuca sativa*) because it is most frequently cultivated in Ouagadougou in both the dry season, and in the rainy season [8]. In addition, because Furthermore it is one of the most consumed crops and the most sprayed with chemical pesticides and even in the spreading of fertilizers [8]. As lettuce is a leafy vegetable, chemical inputs are deposited directly on its leaves at a high dose and at a very short DAR. Thus, lettuce is highly contaminated, even though it is mainly consumed in its raw state. Once rotting begins in a lettuce leaf, it is no longer edible.



Figure 2: *Lactuca sativa* L. (Lettuce) more cultivated in Burkina Faso

2.3. Sampling

Sampling was done on three (03) market gardening sites with the aim of bringing the plant material which is lettuce to the laboratory for chemical analyses. Samples were taken on the morning of March 20th, 2020 from three (03) sites and stored in a cool place at National Public Health Agency. Samples are taken and packaged in blue plastic bags. After coding, samples are taken to the laboratory where they are preserved in the freezer. A sampling sheet containing all the information relating to the collection conditions was attached to the three samples.

2.4. Analysis of pesticide residues

The analysis is carried out by Gas Chromatography coupled with mass spectrometry (CPG/MS). The type of extraction is that of **QUECHER**, which is an American method used especially for fruits and vegetables with a water content greater than 80%. The protocol consists of three essential steps: sample preparation, pesticide extraction and analysis.

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2.4.1. Sample preparation

The ~~16 acetone decontamination of 16~~ 50 ml bottles ~~with were acetone~~ distributed as follows: 4 extraction bottles, 4 purification bottles, 4 test sample bottles and 4 bottles for the analytical portion.

Extraction kit: ~~which are 4 numbered bottles in number and each bottle containing~~ 4 g of magnesium sulfate (MgSO₄), 1 g of sodium chloride (NaCl), 1 g of trisodium citrate dihydrate, 0.5 g of sodium citrate dibasic sesquihydrate.

Purification Kit: ~~which are also 4 bottles and each tube containing~~ 0.15 g Primary and Secondary Amine (PSA), 0.9 g MgSO₄. ~~Acetone Decontamination of the lettuce shredder as before use with Acetone~~

Crushing lettuce: 500 g of frozen lettuce is cut into small pieces and put in a crushing device. Each time a ~~new~~ sample is crushed, the device is decontaminated ~~because the samples are not from the same site.~~ Test portion of 5 g of crushed lettuce in a 50 ml bottle for analysis.

2.4.2. Extraction

The extraction is composed of several steps: ~~which are:~~

Analytical portion of Boulmiougou: Take 5g of crushed lettuce + 10mg ACA (Acetonitrile) + 1 extraction kit, all in a bottle. Mix everything together with a vortex mixer for one minute;

Centrifugation: Centrifuge the mixture ~~at 3500 RPM for one minute in an apparatus which makes 3500 revolutions in one minute. Obtaining a solid phase (organic molecules will be present at the pellet) at the bottom and the supernatant contains liquid phase at the top (inorganic molecules);~~

Purification: Take 6ml of the supernatant + a purification kit. Mix with a vortex mixer for one minute;

Centrifugation: Centrifuge the mixture ~~at 3500 RPM for one minute in an apparatus which makes 3500 revolutions in one minute~~. Take 500 microliters of the supernatant and put it in a vial for analysis.

2.4.3. Sample analysis

The analysis of 500 microliters of the supernatant is done by Gas Phase Chromatography coupled with a Mass Spectrometer (GC/MS) connected to a computer with software. The result came out in the form of a chromatograph and a table.



Figure 3: Equipment of Gas Phase Chromatography

The quantity of pesticide residues (Re) expressed in mg/g was calculated using the following relation.

$$Re = C_x \frac{V}{v} \quad (1)$$

V: extraction volume (0.01 L),

v: volume of test portion (5 g).

C_x = Concentration of the compound given by chromatography (mg/L)

Comment [L7]: Please correct. How could volume be expressed in g?

3. RESULTS AND DISCUSSION

3.1. Chemical composition of pesticide residue molecules

To counter the actions of pests, different control methods are implemented, the most common of which is the application of phytosanitary products. Three samples of lettuce were analyzed, including one sample per site. The various results reveal that all the samples are contaminated by more than fifty molecules, the main ones of which are presented in Table 1 according to the different sites.

Pesticides applied to crops mainly belong to 4 large chemical families: Carbamates, organochlorines, chlorophenyls and pyrethroids. The active ingredients of pyrethroids are the most frequently found (~~because they are~~ present in all samples). The concentrations of pesticide residues found are lower than those established by Codex, therefore they are legally acceptable. Results obtained from the chemical analyzes of the lettuce sample are given in Table 1.

Table 1: Characteristics of Lettuce in 3 sampled sites.

Name of pesticide	Chemical formula	Chemical family	Sampled sites		
			Tanghin	Kossodo	Boulmiougou
Methomyl	C ₅ H ₁₀ N ₂ O ₂ S	Carbamate	1.02	0.98	-
Chlordimeform	C ₁₀ H ₁₃ ClN ₂	organochlorine	0	0	2.42
Quintozene	C ₆ Cl ₅ NO ₂	Chlorophenyl	0	0	0.56
Lindane	C ₆ H ₆ Cl ₆	Organochlorine	0	0	0.94
Cypermethrine	C ₂₂ H ₁₉ Cl ₂ NO ₃	Pyrethrinoids	0.82	0.82	0.88
α-Cypermethrine	C ₂₂ H ₁₉ Cl ₂ NO ₃	Pyrethrinoids	0.84	0.84	0.78
δ-Deltamethrine	C ₂₂ H ₁₉ Br ₂ NO ₃	Pyrethrinoids	0	0.84	0.84

(-): not found

The highest quantities of residues are those of the Chlordimeform molecule (2.42) from the organochlorine family followed by the methomyl molecule (1.02) from the carbamate family. The use of pesticides from the organochlorine family is prohibited according to international texts. The pyrethroid family is the most numerous (Cypermethrine, alpha Cypermethrine, and Deltamethrin).

The pesticide inventory revealed twenty-seven (27) trade names of pesticides used by market gardeners, including a biopesticide. According to the target, the most used pesticides are insecticides (70.37%) because insects are increasingly resistant to insecticides and cause more destruction. This result corroborates ~~sd with~~ the previous study ~~who that also counted reported~~ 27 trade names of pesticides on market gardening sites and the most used are insecticides.

For the fight against pests, results of our surveys revealed that 98.75% of vegetable producers used chemical pesticides. This result is contrary to the conclusion of Diogoet *al.* [9] from Benin where all the producers surveyed use organic pesticides that they prepare themselves. It is a mixture of neem leaves and certain spices including garlic.

Chemical analyzes of lettuce samples revealed three (03) chemical families of insecticides and one family of fungicides, the highest quantities of which are organochlorines, carbamates and pyrethroids and

Comment [L8]: Specify units!!!

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chlorophyll. This result is close to corroborate that found by Diop[7] from Senegal, which found in lettuce: the quantity of organophosphates is greater than that of pyrethroids, which are also greater than those of organochlorines, which are also greater than carbamates.

Comment [L10]: Is chlorophyll an insecticide???

3.2. Identification of chemical molecules in pesticides

After the analyses, seven (07) molecules of pesticide residues were found, distributed as follows: six (06) in Boulmiougou, four (04) in Kossodo and three (03) in Tanghin. Figure 4 gives us the summary of the chemical analyses. Higher dose of Chlordimeform was obtained in Boulmiougou lettuce.

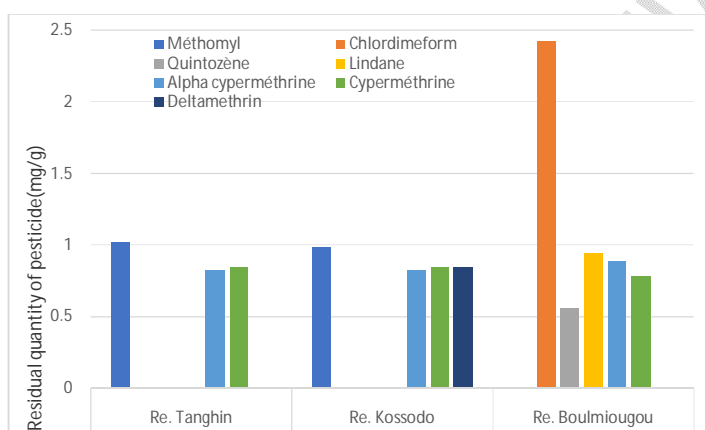
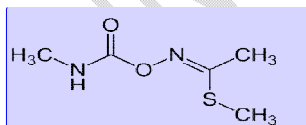


Figure 4: Residual quantity of pesticides molecules in different sites.

From chemical analysis, six insecticides and one fungicide have been observed and classified as well:

One molecule from the carbamate family (Méthomyl) which are insecticides derived from carbamic acid. According to Tarnagdaet al. [10], the half-life of carbamates is estimated between 10 to 20 days. Its concentration is highest in Tanghin, followed by that of Kossodo.

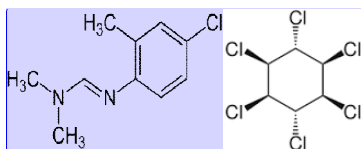


Méthomyl(C₅H₁₀N₂O₂S)

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Two organochlorine molecules (Chlordimeform and Lindane) which are insecticides composed of carbon, hydrogen and chlorine atoms. They are also called chlorinated hydrocarbons, chlorinated organic products. They are still called Persistent Organic Pollutants where their half-life varies between 28 days to

12.8 years in vegetables [10]. Their concentrations are the highest compared to the others and found only in the Boulmiougou sample.

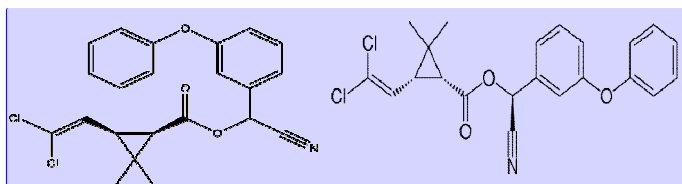


Chlordimeform ($C_{10}H_{13}ClN_2$)

Lindane (C_6Cl_6)

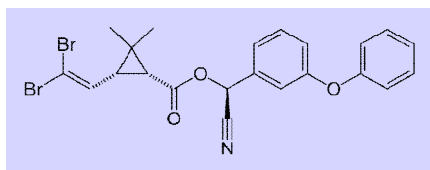
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Three molecules of the pyrethroid family (cypermethrin, α -cypermethrin and δ -deltamethrin) are synthetic insecticides and derivatives of pyrethrins. Their half-life is estimated at 5 to 7 days [10]. They are the most numerous and their concentration is approximately the same in the three samples.



Cypermethrine ($C_{22}H_{19}Cl_2NO_3$)

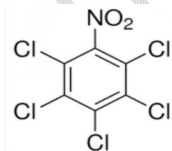
α -cypermethrine ($C_{22}H_{19}Cl_2NO_3$)



δ -Deltamethrine ($C_{12}H_{19}Br_2NO_3$)

Comment [L13]: Ibid

One molecule from the chlorophenyl family (Quintozene) which is part of fungicides. This is the lowest concentration and is present in the Boulmiougou sample only. The use of all pest control products containing quintozene in vegetable crops has been banned since April 26, 2015 in Canada by the Pest Control Regulatory Agency. These reasons concern exposure in the workplace, and through diet, persistence in the environment, bioaccumulation, etc.



Quintozene ($C_6Cl_5NO_2$)

Comment [L14]: Perhaps you should elaborate further. Why is it used in your country? How could it be banned? What can science do for the people?

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The classification of pesticide quantity was given as follow: the highest quantity of residues are organochlorines, followed by carbamates, then pyrethroids and finally chlorophenyls.

4. CONCLUSION

Chemical analyzes revealed several active ingredients belonging to the family of organochlorines, pyrethroids, carbamates and chlorophenyls. The use of chemical inputs in market gardening, in addition to fertilizers to increase yields, pesticides to protect crops against pests remains a major issue in West Africa, particularly in Burkina Faso.

Thus, seven (07) pesticide residues were found and divided into four (04) major chemical families. These are three (03) families of insecticides and one (01) family of fungicides. For insecticides, the presence of carbamates (mythomyl), organochlorines (Chlordimeform and Lindane) and Pyretrinoïds (Cypermétrine, α -Cypermétrine, and δ -deltamétrine) is noted. Regarding fungicides, only the chlorophenyl (quintozene) family was present.

Comment [L16]: In what sense? Please try to discuss further.

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