Fate of Lambda-Cyhalothrin in Kales, Tomatoes and Cabbage from Rural setting in Kenya.

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Abstract

A vegetable is any part of a plant that is consumed by humans as food as part of a savory course or meal. They are highly nutritious and form as key food commodity in the human consumption. They are also highly perishable due to their low shelf life. A diet rich in vegetables and fruits can lower blood pressure, reduce risk of heart disease and stroke, prevent some types of cancer, lower risk of eye and digestive problems. When researchers combined findings from the Harvard studies with several other long-term studies in the U.S. and Europe, and looked at coronary heart disease and stroke separately, they found a similar protective effect: Individuals who ate more than 5 servings of fruits and vegetables per day had roughly a 20 percent lower risk of coronary heart disease and stroke, compared with individuals who ate less than 3 servings per day. Pesticide residues are the major contaminants found in vegetables. Pesticides are used in management of pests and diseases in Agricultural and Horticultural crops. They can leave adverse effects on the nervous system. Some harmful pesticides can cause several hazardous diseases like cancer, liver, kidney, and lung damage. Certain pesticides can also cause loss of weight and appetite, irritability, insomnia, behavioral disorder and dermatological problems. There are many pesticides in use today including; insecticides, acaricides, nematocides, herbicides, and avicides. Pyrethroids are the most commonly used insecticides. The pyrethroids in use include; deltamethrin, lambda-cyhalothrin and chismethrin. Lambda-cyhalothrin was analyzed in some selected vegetables (kales, cabbages and tomatoes) in this study. The samples were obtained from different sellers in some rural setting in Kenya known as Makuyu, during the dry and wet seasons. They were extracted for the lambda-cyhalothrin using organic solvents. The residues were then determined using high performance liquid chromatography (HPLC). The analysis of the data was done using t-test, regression analysis and ANOVA. In this case, lambda-cyhalothrin was analysed in vegetable samples obtained from the urban area (Nairobi Markets) during the dry and wet seasons. It was observed that the samples analysed during the dry season had higher residue levels of lambda-cyhalothrin (ranging from 0.0300 mg/kg to 0.3400 mg/kg), than those analysed during the wet season which, ranged between 0.0001 and 0.0040 mg/kg. The difference between the two seasons was significant at 95 % confidence level, ($t_{(8,\ 0.05)}$ = 2.31 and $t_{calculated}$ =4.30). Almost all the samples analysed during the wet season had undetectable levels of lambda-cyhalothrin. The residue levels observed during the dry season were higher than the FAO/WHO's ADI of 0.02 mg/kg, but less than the FAO/WHO's MRLs of 0.2 mg/kg (FAO/WHO, 1996), while the levels of lambda-cyhalothrin obtained during the wet seasons were all lower than the two bodies' set standards.

Keywords : Vegetables, Rural setting, Pyrethroids, Lambda-cyhalothrin and HPLC

1.0 Introduction

The term *vegetable* is somewhat arbitrary, and largely defined through culinary and cultural tradition. It normally excludes other food derived from plants such as fruits, nuts, and cereal grains, but includes seeds such as pulses. The original meaning of the word *vegetable*, still used in biology, was to describe all types of plant, as in the terms "vegetable kingdom" and "vegetable matter" (Hillman, 1996).

Originally, vegetables were collected from the wild by hunter-gatherers and entered cultivation in several parts of the world, probably during the period 10,000 BC to 7,000 BC, when a new agricultural way of life developed. At first, plants which grew locally would have been cultivated, but as time went on, trade brought exotic crops from elsewhere to add to domestic types. Nowadays, most vegetables are grown all over the world as climate permits, and crops may be cultivated in protected environments in less suitable locations. China is the largest producer of vegetables and global trade in agricultural products allows consumers to purchase vegetables grown in faraway countries. The scale of production varies from subsistence farmers supplying the needs of their family for food, to agribusinesses with vast acreages of single-product crops. Depending on the type of vegetable concerned, harvesting the crop is followed by grading, storing, processing, and marketing (Hillman, 1996).

Living organisms evolve and increase their resistance to biological, chemical, physical or any other form of control. Unless the target population (for example the pests) is completely exterminated or is rendered incapable of reproduction, the surviving population will inevitably acquire a tolerance of whatever pressures are brought to bear - this results in an evolutionary arms race. A pest is "a plant or animal detrimental to humans or human concerns (as agriculture or livestock production)" (Merriam, 2012). Alternative meanings include organisms that cause nuisance and epidemic disease associated with high mortality (specifically: plague). In its broadest sense, a pest is a competitor of humanity (Pest Vermin, 2016). There are now many chemicals with which pests, diseases and weeds can be controlled. It would be reasonable to state that neither could we have achieved nor can we maintain the standard of living, which we enjoy today without the use of these chemicals. Almost all these chemicals are poisonous to creatures besides those, which they are intended to kill. Thus, they can be very dangerous to the life of humans, animals, fish, and birds. There is therefore, need for monitoring the levels of pesticides residues in the vegetables. The class of pesticides commonly used on vegetables is the insecticides, and mostly the pyrethroids insecticides such as lambda-cyhalothrin (Shan, 1989).

In this study, therefore, Lambda-Cyhalothrin residues levels were investigated in vegetables. Cyhalothrin is an organic compound that is used as a *pesticide* (Cameo Chemicals, 2008). It's a class of man-made insecticides that mimic the structure and insecticidal properties of the naturally occurring insecticide pyrethrum which comes from the flowers of chrysanthemums. Synthetic pyrethroids, like lambda-cyhalothrin, are often preferred as an active ingredient in insecticides because they remain effective for longer periods of time. Pyrethroid is a colorless solid, although samples can appear beige, with a mild odor. It has a low water solubility and is non-volatile. It is used to control insects in cotton crops (Robert, 2002). The crops on which it may be applied include cotton, cereals, ornaments, potatoes and vegetables. Its molecular formula is $C_{23}H_{19}C1F_3NO_3$.

Lambda-cyhalothrin is a colourless solid at room temperature. Lambda-cyhalothrin is rapidly hydrolysed under alkaline conditions but not in neutral or acidic media. The minimum detection limit of lambda-cyhalothrin during the analysis done by FAO/WHO joint is 0.005 mg/kg (FAO/WHO, 1986). Trade names for products containing lambda-cyhalothrin include charge, excaliber, grenade, hallmark, icon and karate (Hart, 1984). In

Kenya, it has the trade name karate. Lambda-cyhalothrin is known to produce an effect described as subjective facial sensation (SFS) in some people who work with this compound (Hart, 1984). The extent of sensation is more likely to be related to the amount of the chemical that comes into contact with the facial skin (Hart, 1984). Signs of intoxication are characteristic of type II pyrethroid toxicity and include piloerection, subdued behavior, ataxia, unsteady gait, salivation, incontinence, scouring, and chromodacryorrhoea (Nixon *et al*., 1981). High levels of these insecticides on consumable foods can be injurious to the population and hence the need for continued monitoring of the levels of pesticides residues in vegetables.

2.0 Methodology

2.1 Sample collection and pre-treatment

The vegetable samples analysed were obtained from different vegetable dealers in Makuyu Market in Kenya, during the dry season and wet seasons. They include; kales (sukumawiki) (*Brassica Oleracea C.),* cabbage (*Brassica Oleracea A.)* and tomatoes (*Lycopersicon Esculentum*). These are the most commonly consumed vegetables in the Kenyan markets today. The vegetables were then sorted out, weighed and then homogenized to make a representative sample. The samples were finally put in clean polythene bags, labeled and then stored safely in a refrigerator at –4^{o}C awaiting extraction and analysis. Plate 1, shows different types of vegetables consumed globally.

Plate 1. Assorted variety of Vegetables.

2.2 Cleaning of glass and plastic containers

All the glassware used in this study were soaked for 12 hours in freshly prepared chromic acid. They were then rinsed with distilled-deionised water. They were then soaked in distilled-deionised water for about 6 hours to leach off any adsorbed chromic ions. Finally, they were dried in oven after rinsing them with fresh distilled-deionised water. Plastic containers were thoroughly cleaned with detergents and then rinsed several times with 6M Analar nitric acid. They were then rinsed thoroughly with distilled-deionised water and dried in an open rack. They were then stored safely in a clean environment till required.

2.3 Reagents and solvents

All the chemicals and reagents used in this research were of analytical grade and included;
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i. Hexane-Glass distilled–from Kobian distributors limited (Nairobi, Kenya)
ii. Acetone- Glass distilled–from Kobian distributors limited (Nairobi, Kenya)
iii. Florisil–from Kobian distributors limited (Nairobi, Kenya)
iv. Diethyl ether- Glass distilled–from Kobian distributors limited (Nairobi, Kenya)
v. Analytical standard for deltamethrin-from Britain at Aldrich limited (Britain)
vi. Acetonitrile- HPLC grade–from Kobian distributors limited (Nairobi, Kenya)
vii. Water –Distilled and deionised HPLC grade

2.4 Preparation of the standards and the calibration curve

Stock standard solution (of Lambda-Cyhalothrin standard) was prepared using isooctane. Working standards for HPLC/DAD calibration were prepared by serial dilution of the stock standard solutions using isooctane. The series consisted of eight calibration levels each with different concentration as shown in Table 2.2 below:

Table 2.2: Serial dilutions of the stock standard

Vial	**Concentration of Lambda-cyhalothrin standards**
1.	0.80
2.	0.64
3.	0.50
4.	0.34
5.	0.12
6.	0.10
7.	0.05
8.	0.01

The purpose of the calibration was to ascertain the relationship between the amount of standard injected and peak area at the specific retention time for the pesticide.

The Spectra for Lambda-Cyhalothrin was used to ascertain the compound, identified by virtue of its abundance and mass to charge ratios. A spectrum in this case refers to a fragment unique to a certain molecule; while the fragments represent various masses, which are unique to the compound. In this case a library with specific spectra for pesticides was used, which has about 600 pesticides.

2.5 Statistical Analysis

The data was evaluated using mean, the standard deviation, t-test and one-way [1]ANOVA. The significant tests were done at p= 0.05 (Miller and Miller, 1992).

3.0 Results and Discussions

The Lambda-cyhalothrin was determined using [2]HPLC-DAD in all the samples, after a column clean-up with florisil. Table 1 and Figure 1 shows the results obtained.

Table 1: Mean residue levels of lambda-cyhalothrin in mg/kg in the samples from the Makuyu during the dry and wet seasons (Mean ± SD, n=10)

Vegetables	Dry season	Wet season	$t_{(8, 0.05)}$	$t_{calculated}$	Difference
Kales	0.0130±0.0200	0.0018±0.0040	2.31	1.20	Not significant
Cabbages	0.0500±0.0300	0.0050±0.0400	2.31	2.00	Not significant
Tomatoes	0.0500±0.0400	0.0020±0.0045	2.31	2.67	Significant

The mean residue levels of lambda-cyhalothrin in the samples, ranged between 0.0130 mg/kg and 0.0500 mg/kg during the dry seasons, and between 0.0018 mg/kg and 0.0020 mg/kg during the wet season. The results are as shown in the Tables 1. Cabbage and tomatoes had higher levels of lambda-cyhalothrin than kales. It can be also being observed from the same table that the mean residue levels of lambda-cyhalothrin in the samples analysed during the dry season were higher than those analysed during the wet season, with the graphical presentation as shown in Figure1.

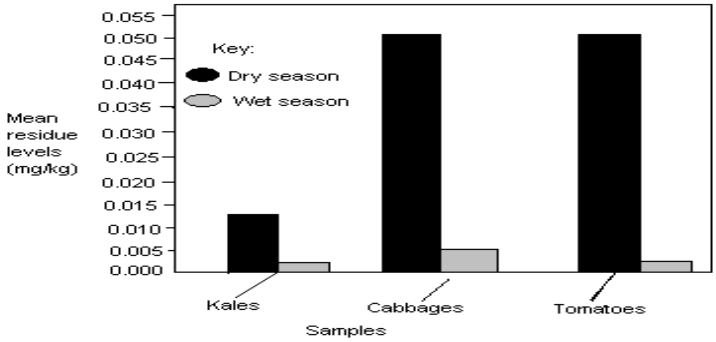

Figure 1 Graphical presentation of mean residue levels of lambda-cyhalothrin in samples analysed from the rural areas during the dry and wet seasons

3.1 Levels of lambda-cyhalothrin in kales

During the dry season, the lambda-cyhalothrin mean residues levels of 0.0130 mg/kg were higher than the residues found during the wet season of 0.0018 mg/kg (Table 1 and Figure 1) in the kale samples analysed. However, there was no significant difference between the two mean residues levels ($t_{(8, 0.05)}$ = 2.31 and $t_{calculated}$ = 1.20). The two levels were less than the ADI by FAO/WHO (1996) of 0.02 mg/kg and still they were both less than the MRLs by FAO/WHO (1996) of 0.2 mg/kg.

[1] ANOVA- Analysis of Variance
[2] High Performance Liquid Chromatography coupled with Diode Array Detector

3.2 Levels of lambda-cyhalothrin in cabbage

Looking at the results of lambda-cyhalothrin for cabbage samples from rural areas, it was found that they had higher mean residue levels of 0.0500 mg/kg during the dry season than during the wet season which was 0.0050 mg/kg (Table 1 and Figure 1). There was no significant difference between the two lambda-cyhalothrin mean residue levels ($t_{(8,\ 0.05)}$ = 2.31 and $t_{calculated}$ = 2.00. The samples analysed during the dry season had higher levels of residues than the ADI of 0.02 mg/kg and less level than the MRLs of 0.2 mg/kg (FAO/WHO, 1996). On the other hand, the residues during the wet season were found to be less than the ADI of 0.02 mg/kg and still less level than the MRLs of 0.2 mg/kg (FAO/WHO, 1996).

3.3 Lambda-cyhalothrin in tomato samples

The tomato samples analysed from during the dry season had higher residues levels of lambda-cyhalothrin of 0.0500 mg/kg than those analysed during the wet season of 0.0020 mg/kg (Table 1 and Figure 1). There was a significant difference between the two mean residue levels ($t_{(8,\ 0.05)}$ = 2.31 and $t_{calculated}$ = 2.67). The tomato samples analysed during the dry season had higher residue level than the ADI of 0.02 but are less than the MRLs of 0.2 mg/kg (FAO/WHO, 1996). On the other hand, the residues determined during the wet season were less than both the ADI of 0.02 mg/kg and MRLs of 0.2 mg/kg (FAO/WHO, 1996).

4.0 Conclusion

The study revealed that Lambda-cyhalothrin was detected in all the vegetable samples analysed during the dry and wet seasons. The Cabbage and the tomato samples analysed during the dry seasons had higher residue levels of Lambda-cyhalothrin than the ADI set standards, by FAO/WHO, 1996 while the Kales samples had less levels both during the dry and wet seasons. It's therefore, advisable for the farmers to wait for the elapse time before harvesting the vegetables after the pesticides application. This problem can also be curved if the farmers follow the label instructions by applying the right amount of the pesticides as is recommended by the manufacturers. The consumers on the other hand should make sure they wash their vegetables thoroughly before consumption.

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