

FINAL REPORT

PERSISTENCE OF KARATE AND DECIS ON CALLALOO UNDER NATURAL FIELD CONDITIONS IN JAMAICA, AND DURING POST-HARVEST STORAGE AND PROCESSING.

Principal Scientists

Dr. Dwight E. Robinson
Dr. Raymond Reid

Investigating Scientists

Ms. Rakay Bennett
Ms. Sharla Williams

Departments of Life Sciences and Chemistry
The Faculty of Pure and Applied Sciences
The University of the West Indies
Mona, Kingston 7.

May 2011

PERSISTENCE OF DECIS AND KARATE ON CALLALOO UNDER NATURAL FIELD CONDITIONS IN JAMAICA, AND DURING POST-HARVEST STORAGE AND PROCESSING.

Introduction

Callaloo (*Amaranthus viridis* L.) is an annual herb grown in Jamaica as a leaf vegetable initially on small holdings and backyard gardens as a source of iron in the Jamaican diet, but over the last two decades has grown into a very important export crop (Clarke-Harris *et al.* 1998¹). Several Lepidopteran and Coleopteran insects feed on the leaves of the plant and have attained major pest status on the crop. In order to limit economic losses associated with these pest species, many farmers rely primarily on chemical control and often use a variety of insecticides - either in rotation or as cocktail mixtures - in an effort to suppress populations of the pests.

In many instances, pesticides are applied above the recommended rate and the crop is usually harvested at a fixed time after spraying for consumption. The reentry period stated by the manufacturer may or may not be adhered to and, with a paucity of data on the persistence of the various insecticides being used on the crop under typical Jamaican conditions, the risk to persons consuming the crop cannot be assessed. The present study was therefore designed to determine the persistence of two insecticides - Karate (lambda - cyhalothrin) and Decis (deltamethrin) - on callaloo under field conditions, as well as the impact of procedures done during preparation and cooking on the persistence of the residues of these insecticides that are on the crop at the time of harvest.

Project Goal and Objectives

Goal: To determine the persistence of Karate and Decis on callaloo under a typical Jamaican field condition.

Objectives:

1. Determine the levels of Karate and Decis residues on callaloo at different time-periods after treatment.

¹ Clarke-Harris, Dionne, Fleischer, Shelby and Fender, Andrea. 1998. Identification Guide: Major pests of callaloo. 16 pp.

2. Determine the levels of Karate and Decis residues on callaloo at harvest and at different stages during post harvest, processing and cooking.
3. Generate half-lives for the insecticides under the specific field condition using appropriate regression models.

Methodology

Three callaloo plots (4 x 4 metres) were established in the Botany Gardens in the Department of Life Sciences, The University of the West Indies, Mona. Three weeks after establishment of the plots, they were treated with Karate (a.i.: lambda-cyhalothrin) and Decis (a.i.: deltamethrin) at a rate of 0.07 ml per plant using a 15L Cooper Pegler® air compression sprayer. Two sets of three leaves were randomly selected from each plot 1 hour, and 1, 3, 5, 7 and 10 days after treatment. The samples were stored in labeled plastic bags at 0-5°C for residue extraction and analysis at a later date. The quantity of rainfall was recorded during the period of sampling.

Callaloo plants (approximately 200 grammes) were randomly selected and harvested on Day two after treatment. The harvest plants were mixed and divided into eight equal portions. Two portions of the sample were randomly selected for one of the following processes: Determination of the residues at harvest, after storage on a table top for a 12-hour period, after rinsing with salt water or after preparation for consumption by steaming. Samples put through these processes were stored in labeled plastic bags at 0-5°C for residue extraction and analysis at a later date. The residual salt water used for washing and liquid generated during the steaming process were also collected and stored in labeled flasks at 0-5°C for residue extraction and analysis.

Residue extraction and analysis

About 20-30g of the callaloo samples were cut in small pieces and placed in a commercial 2-speed blender containing the extraction solvent (Methylene chloride, DCM or hexane) and blended for two minutes at high speed. The sample was filtered (Whatman filter paper #2) and the filtrate dried with about 50g of anhydrous sodium sulphate. The dried liquid was decanted into a 250 mL round bottom flask and concentrated to about 2 mL using a rotary evaporator.

The 2 mL of evaporated sample extract was transferred to a 20 cm activated florisil column and eluted with 50 mL of Hexane, 50 mL of 15% DCM/Hexane (v/v) and 150 mL of 60% DCM/Hexane (v/v). Each of the 3 fractions was separately rotaevaporated (after adding 5 mL of iso-octane – Optima grade) to 1.0 mL. 1 uL of the extract was analysed by an Agilent 6890 GC-MS fitted with a HP 5MS column (0.25mm x 0.25 um x 30m). A calibration curve was prepared in the range of 0 – 10 mg/L for Decis and 0 -100 mg for karate. Detection limit of instrument is less than 10 ug/L.

Results and Discussion

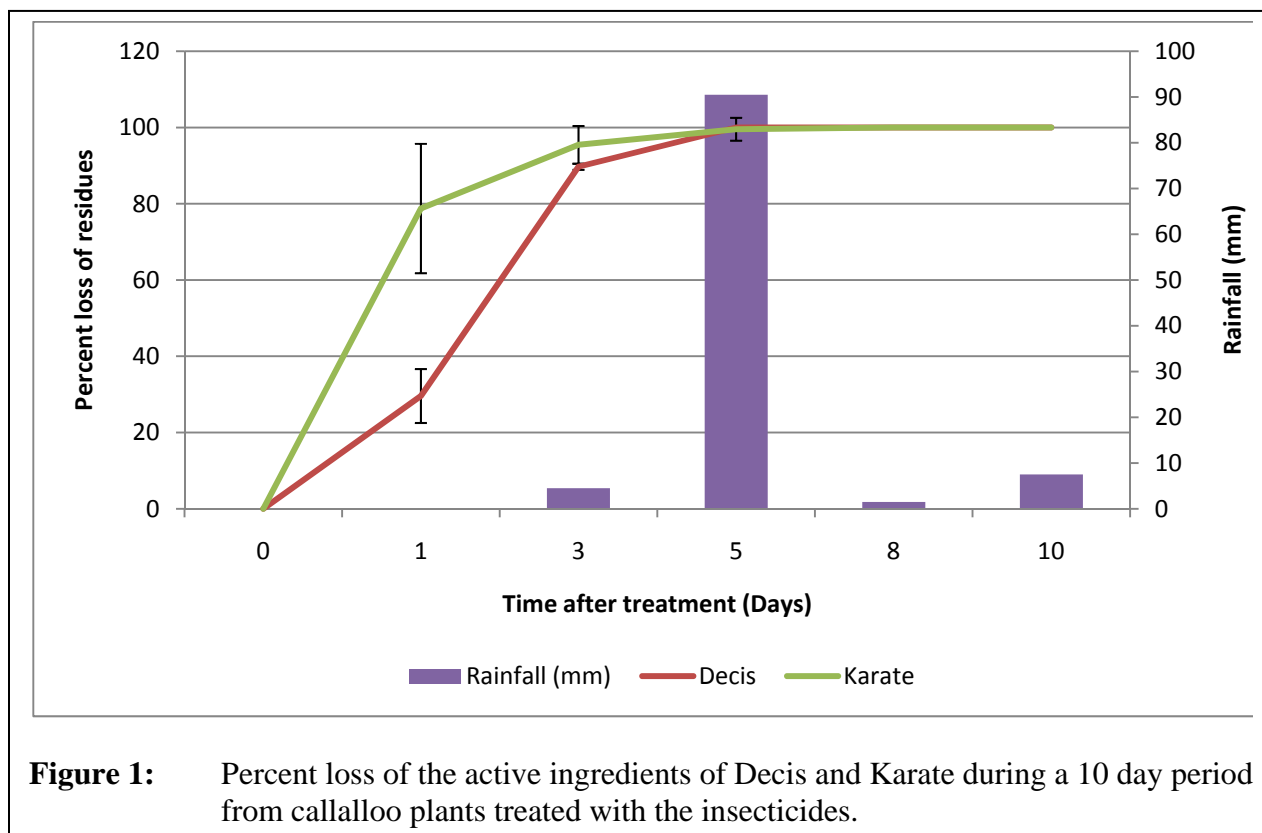
Table 1 presents data on the concentration of Decis and Karate residues recovered from callaloo at different times after treatment. Since the initial concentrations of both insecticides were so vastly different, the data was transformed to percent of initial (Day 0) recovery to allow for a more meaningful comparison (Figure 1).

Within 24 hours after treatment $78.8 \pm 16.9\%$ of the Karate applied to the callaloo was lost compared to only $29.6 \pm 7.1\%$ of the Decis (Figure 1). On day three after treatment $95.5 \pm 4.9\%$ and $89.7 \pm 0.8\%$ of Karate and Decis, respectively, had already been lost. No Decis or Karate residues were detected on the callaloo after days three and five after treatment, respectively. While rainfall (4.5 mm) may have contributed to the 60.1% of Decis and 16.7% of Karate residues lost between days three and five after treatment, the rapid losses during the first 24 hours after treatment, when no rain fell, suggest that factors other than rainfall contributed to the loss of the insecticides.

Table 1: Concentrations of the active ingredients of Decis and Karate on callaloo plants different days after treatment.

Time after treatment (days)	Rainfall (mm)	Pesticide concentration ($\mu\text{g}/\text{kg}$)	
		Decis	Karate
0	-	7.05 ± 0.11	69.70 ± 1.98
1	0	4.96 ± 0.35	14.80 ± 0.85
3	4.5	0.51 ± 0.11	3.17 ± 0.25
5	90.5	nd	0.32 ± 0.15
8	1.5	nd	nd
10	7.5	nd	nd

nd = not detected



This is most evident in relation to Karate residues, which were reduced by 78.8% prior to rainfall. The relatively low solubility of the insecticides (Worthing 1987²) makes them less susceptible to wash-off in solution with rainwater. It is interesting to note that while the initial decline of Karate residues was faster than that of Decis, the Karate persisted longer. However, under the prevailing field condition at the time, the estimated half-lives of the insecticides were 0.44 and 1.36 days for Karate and Decis, respectively. This suggests relatively low persistence of the insecticides under Jamaican field conditions.

Table 2: Half-life of Decis and Karate on callaloo plants cultivated in Mona during November 2010.

Insecticides	Half-Life (Days)	Confidence Intervals (95%)	Slope
Decis	1.36	1.20 – 1.52	4.130 ± 0.385
Karate	0.44	0.22 – 0.65	2.164 ± 0.362

² Worthing, C.R. (ed.) 1987. The pesticide manual. Great Britain. Lovinham Press.

The concentrations of Decis and Karate on treated callaloo at the time of harvest, after storage for 24 hours, and after washing and cooking are presented in Table 1. Generally, Karate was more persistent under storage and processing than Decis (Figure 2). Callaloo treated with Decis and Karate lost $24.3\pm 0.1\%$ and $7.8\pm 2.5\%$ of the residues, respectively, when stored in the refrigerator for a 24-hour period, while $48.2\pm 1.5\%$ and $22.3\pm 0.5\%$, respectively, of the residues were lost when the insecticides were stored on an open shelf for a similar period.

Washing the callaloo in salt water, a practice usually done in Jamaica, resulted in the removal of $44.1\pm 0.8\%$ of Decis and $16.4\pm 0.4\%$ of Karate, while cooking resulted in a 100% and $89.3\pm 0.5\%$ loss of the respective insecticides. Water used to wash the callaloo had 5.25 ± 0.53 $\mu\text{g}/\text{kg}$ of Karate in the water, while the liquid obtained in the cooked callaloo had 1.37 ± 0.06 $\mu\text{g}/\text{kg}$ of the insecticide. The fact that no Decis residue was recovered from the water used to wash callaloo treated with Decis, or in the liquid obtained from cooking the callaloo, was unexpected. While the absence of Decis residues from the liquid in the cooked callaloo may be as a result of transformation of the insecticide under increased temperature in the presence of water, the absence of residues in the water is anomalous and would need to be verified.

Table 3: Concentrations of the active ingredients of Decis and Karate on callaloo at harvest and after exposure to different postharvest processes.

Sample description	Pesticide Residues ($\mu\text{g}/\text{kg}$)	
	Decis	Karate
Freshly harvested callaloo	10.25 ± 0.21	78.60 ± 1.98
Uncooked callaloo stored in refrigerator for 24 hours	7.76 ± 0.18	72.45 ± 0.92
Uncooked callaloo stored on shelf for 24 hours	5.31 ± 0.11	61.05 ± 2.05
Harvested callaloo	9.90 ± 0.02	79.10 ± 0.99
Callaloo washed with salt water	5.54 ± 0.11	66.15 ± 0.35
Salt water washing from callaloo	nd	5.25 ± 0.53
Cooked callaloo	nd	8.46 ± 0.67
Liquid obtained from cooked callaloo	nd	1.37 ± 0.06

nd = not detected

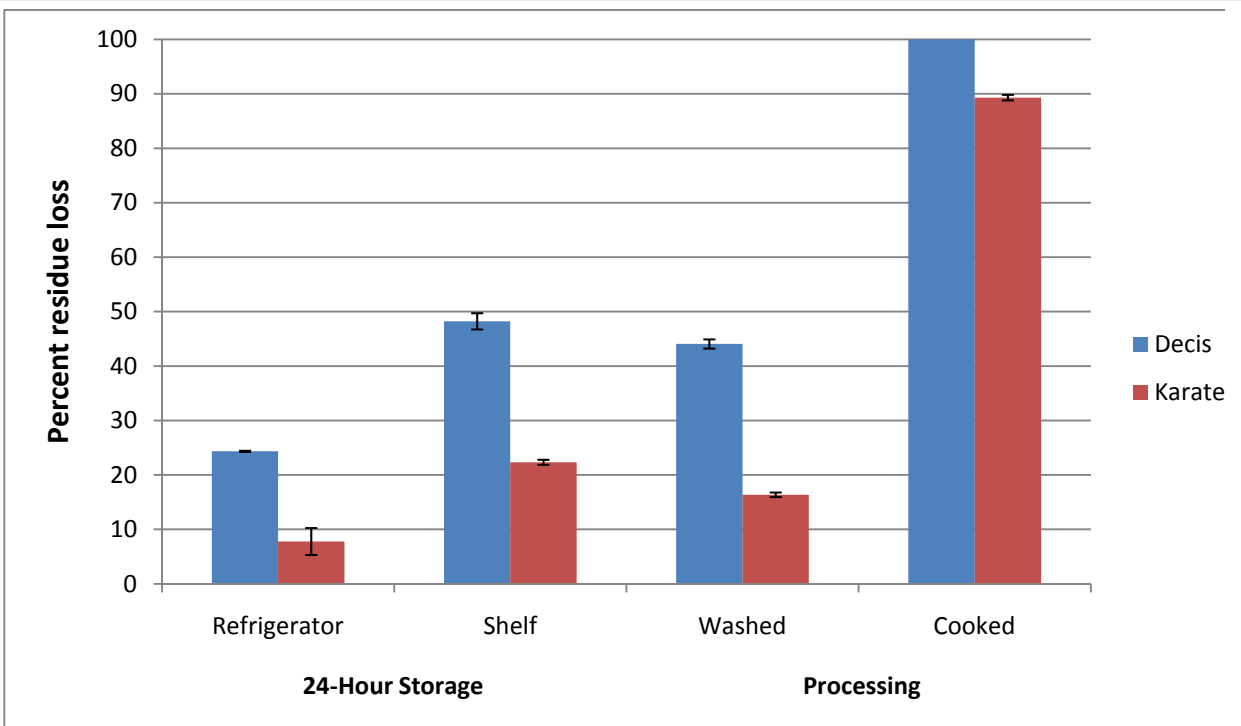


Figure 2: Percent loss of the active ingredients of Decis and Karate from callaloo treated with the insecticides during storage and processing of the callaloo.

Conclusions

- The half-life of Decis on callaloo under the prevailing field conditions at the time of the experiment was 1.36 days (C.I. 95%; 1.20 – 1.52 days).
- The half-life of Karate on callaloo under the prevailing field conditions at the time of the experiment was 0.44 days (C.I. 95%; 0.22 – 0.65 days).
- Storage of harvested callaloo in the refrigerator resulted in a $24.3 \pm 0.1\%$ of Decis residue being lost over a 24-hour period compared to a loss of $48.2 \pm 11.5\%$ of the residue when the callaloo was stored on an open shelf.
- Storage of harvested callaloo in the refrigerator resulted in a $7.8 \pm 2.5\%$ of Karate residue being lost over a 24-hour period compared to a $22.3 \pm 0.5\%$ loss of the insecticide residue when stored on an open shelf.

- Washing with salt-water reduced Decis and Karate residues on the treated callaloo by $44.1 \pm 0.8\%$ and $16.4 \pm 0.4\%$, respectively.
- Cooking reduced Decis and Karate residues on the treated callaloo by 100% and $89.3 \pm 0.5\%$, respectively.
- Liquid from the cooked Karate-treated callaloo had $1.37 \pm 0.06 \mu\text{g}/\text{kg}$ of the insecticide.