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Acaricides Application Rates and Residue Levels in Homemade Sprays, Soil and Water from the Southern Ewaso Nyiro River in Kajiado West Sub County, Kajiado County, Kenya

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ABSTRACT

Acaricides used in controlling ectoparasites (ticks) is the most preferred and economical sound conventional mode of tick eradication. The study aimed at determining acaricide application rates and residue levels in the homemade cattle sprays, soils within the spraying sites and water from the nearby southern Ewaso Nyiro River. The livestock drink river water which is used for domestic purposes. Acaricide residues levels analyzed were those used by farmers in for homemade cattle sprays. The cattle sprays and soil samples were collected from ten selected homes spraying sites randomly from 138 willing farmers in the May and November representing wet and dry seasons respectively in 2018. The sprays were collected after farmers prepared them in the usual way before spraying their animals. The livestock farmers' ways of mixing and application of acaricides after normal preparation was assessed. The different acaricides identified were analysed for active ingredient levels after preparation using Gas chromatography-Mass spectrometry. Water samples were collected from six sites adjacent to the homes where the sprays were prepared since some homes were found to share the same water drawing area. Solvents used were triple distilled for samples extractions. The homemade sprays and water samples were extracted using dichloromethane while Soxhlet method for soil in a mixture of acetone and hexane in the ratio of 1:3. Samples were concentrated using a rotary evaporator and the clean-up through aluminium oxide chromatographic glass column. Refrigerator was used for sample storage while a Hewlett-Packard Agilent Gas chromatography system equipped with a mass

selective detector was used for quantification of acaricide residues levels. Out of the nine acaricides reported by farmers through the questionnaire, three namely amitraz, cypermethrin and deltamethrin were detected in the homemade cattle sprays and soil samples. Amitraz levels ranged from 884±25.3 to 12,236±14.54 µg/L, Cypermethrin was at 3,834±80.2 to 11,972±74.0 µg/L with Deltamethrin at 3,879±33.2 to 12,298 ±82.1 µg/L in the dry while amitraz was at 5,430±96.10 to 11,634±107.2 µg/, 8,975± 103.7 to 10,383±562 µg/L for Cypermethrin while Deltamethrin was only used by home 3 at concentration of 4,781± 125.8 µg/L in the wet seasons in homemade cattle sprays. In the soil, acaricides were in the range of 3,129±98.7 to 10,641±144.2 µg/kg for amitraz, 3,041±33.15 to 8,654±141.2 µg/kg, Cypermethrin and 1,341±58.06 to 8,167±16.4 µg/kg Deltamethrin in dry and 3,875±97.3 to 7,905±184.2 µg/kg amitraz, 4,832±86.7 to 8,694±146.9 µg/kg Cypermethrin. Deltamethrin was only used by home 3 at a level of 2,367±76.9 µg/kg in the wet season. The analysis revealed that homemade cattle sprays in the sub-county had low levels of amitraz, cypermethrin and deltamethrin than those recommended by the manufacturers of 50,000-400,000 µg/L, indicating that the acaricides were over diluted leading to the observed tick re-occurrence in Kajiado West Sub County

Keywords: *Farmers, Homemade cattle spray, water, soil, ticks, Kajiado County*

I. INTRODUCTION

Fate of pesticides to the environment in Kenya and many developing countries has become an issue due to their environmental and health implications [1]. Many countries seek pest management approaches that minimize pesticide use and residues while providing higher pesticide free produce under pre-inspection procedures that can be documented. Contamination arising from pesticides in surface waters have been studied worldwide and is considered a great concern due to their negative impacts on human health and environment of which have been discussed at the Stockholm convention on persistent organic pollutants in 2002 with intent of eliminating or restricting their production [1]. Earlier studies indicate the presence of pesticides and their residues levels within the environment of Lake Victoria, studies by Osoro [2] on main beaches at Rusinga Island in Lake Victoria show presence of DDT, alpha-HCH, and beta-HCH and endrin aldehyde pesticides in water samples. Organochlorines pesticides levels in soils from Nyando catchment Kenya were higher during wet season than dry season [3]. Acaricides are forms of pesticides used in controlling tick transmission and associated diseases. Tick borne diseases and those caused by internal parasites limit livestock productivity due to weight loss and reduction in milk quantities [4]. The most common method of dealing with external parasites in livestock is by use of insecticides and acaricides. However, the use of acaricides has encountered resistance particularly from organochlorine, organophosphates

and pyrethroids [5] by Haematobia irritans, H. irritansexigua and Lucilia Cuprina tick population. Boophilus ticks have also reported resistance to organophosphates, synthetic pyrethroids, amidines and carbamates sparking discussions on new pest management strategies [6]. Several methods have been used to assist minimize effects of tick-borne diseases (TBDs) which include plunge dipping, sprays, showering and putting bands on tails in order to disrupt the vector life cycle [7]. The control of livestock pests mainly employs the use of acaricides however these end up contaminating soil, air and water reservoirs and affecting non-target species [8]. Early studies by [9] indicate need to review the frequency of acaricides application in any herd of cattle.

He further states the start of an immunization system called infection and treatment method that has enabled farmers control ectoparasites through dipping system at increased intervals rather than normal of twice per week. He further recommended more research in area of cost-effective control so as to bring all other tick-borne diseases on board that are a threat to cattle survival [9].

Mugambi [10] reported widespread misuse of acaricides since government stopped controlling acaricides use by farmers. This was further complicated by lack of veterinary extension services who assist in acaricide application. He as well observed a combination of amitraz and other synthetic pyrethroids to improve their efficacy, an issue of concern and could compromise effectiveness of the two acaricides through development of resistance hence a window of insufficient technical knowledge amongst livestock owners. Research by [11] while investigating on whether application rates used in cattle dips met recommended guidelines and whether dissipation affected efficacy of pesticide in dip vat revealed lower amitraz concentrations in both dips compared to recommended dosage.

The aim of this study was to investigate the Pesticide residue levels of selected acaricides in homemade sprays, soil from the sites where cattle were sprayed and water from the Southern Ewaso Nyiro River in Kajiado West Sub County, Kajiado County. The results proved the need for regular environmental assessments with regard to pesticide residues that will guide in understanding levels of exposure and formulation of policies at both national and county levels with respect to potential risks to human health and environment contamination.

II. MATERIALS AND METHODS

2.1 Study site

The study area is an electoral area within Kajiado County with a population density of 82,846 [12] people with office coordinates at 1.4284°S and 36.6852°E. Its administrative units are Keekonyokie, Magadi, iloodokilani, Ewuaso nkidong'I and Mosiro wards. The southern Ewaso Ng'iro (Brown River) flows through the sub county rising on the Mau escarpment and draining to the south part of Mau forest. The forest is under extinction from logging and clearance for farming which may increase sediment load in the river and reduce water volumes [13].

The rainfall pattern is bimodal with short rains between October and December and long rains between March and May with an annual rainfall of 500 millimeters at lake Magadi [14]

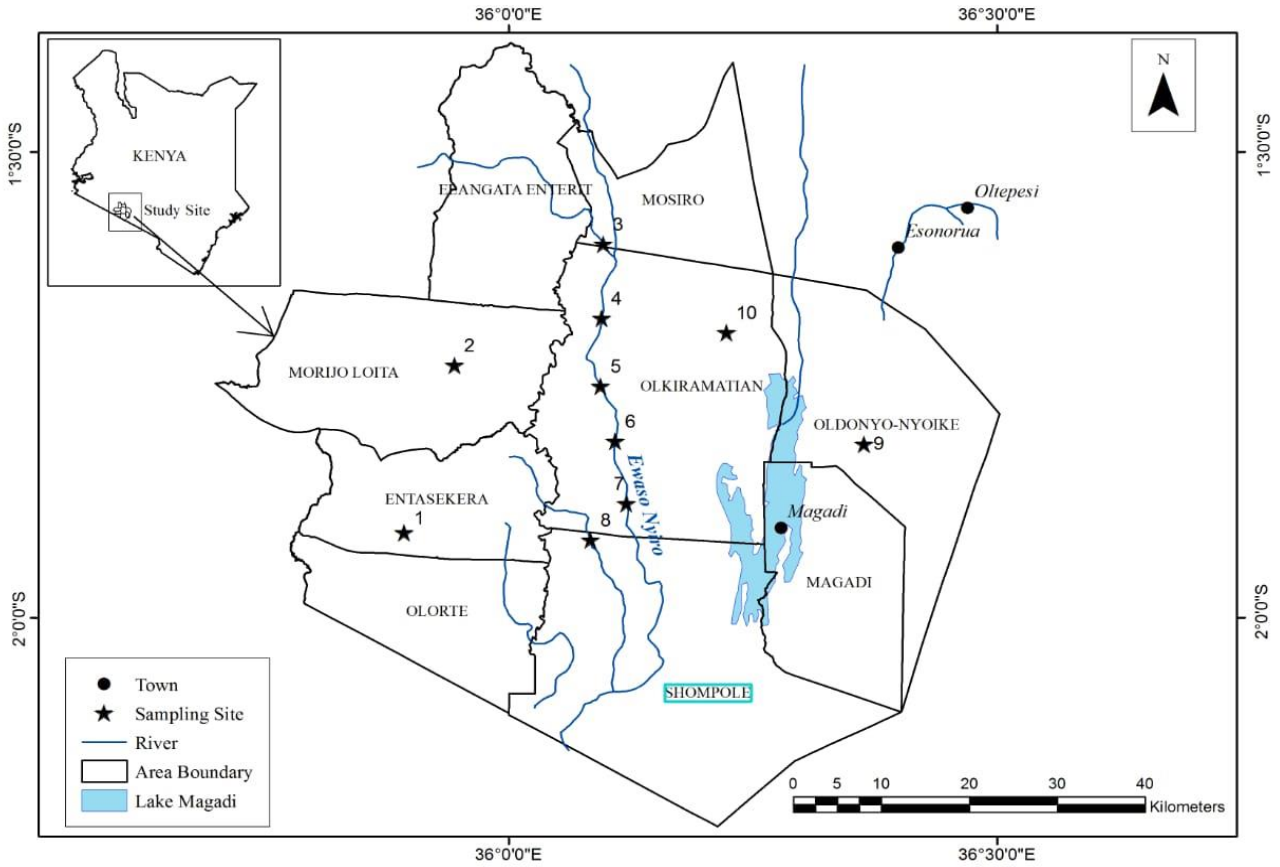

Figure 1. Map of Kajiado West Sub County Showing the Sampling Sites, Source [13]

The sampling sites labelled numbers 1 and 2 are near Ngurumani where subsistence farming in addition to cattle keeping has great potential while sites 9 and 10 are areas of Kamkuru where only cattle rearing is experienced with water scarcity taking prevalence. In the rest of the regions beyond Lake Magadi (3 to 8) there is an additional pest rather than the tick thus the tsetse fly [13]

Table 1 Description of the sampling sites in Kajiado west sub-county

Site	Given name	Longitude	Latitude	Altitude (m)	Human activities around the sampling location
1	Empaleki 1	35^{0}87’03.6E	1^{0}97.06’49S	689	Cattle rearing, subsistence farming of maize, beans, lemons and tomatoes
2	Empaleki 2	35^{0}73’04.5E	1^{0}84’50.13S	699	Cattle rearing, subsistence farming of maize, beans, greens, kales and cabbages
3	Oldoraja	35^{0}96’55.4E	1^{0}86’97.6S	703	Cattle rearing, subsistence farming of maize, beans, vegetables, kales and

4	Esaginy 1	35⁰84’75.2E	1⁰83,54.95S	711	Cattle rearing, subsistence farming of beans, maize, and pawpaw
5	Esaginy 2	35⁰89’32.0E	1⁰73’65.1S	702	Cattle rearing, Subsistence farming of maize, beans and pawpaw.
6	Esaginy 3	36⁰09’97.4E	1⁰88’97.47S	706	Cattle rearing, Subsistence farming of maize, beans, pawpaw and mangoes.
7	Oldonyonyokie 1	36⁰46’23.7E	1⁰82’02.67S	701	Cattle rearing, Chicken rearing
8	Oldonyonyokie 2	36⁰09’97.4E	1⁰65’18.01S	703	Cattle rearing, Chicken rearing
9	Kamkuru 1	36⁰22’91.8E	1⁰78’50.51S	698	Cattle rearing.
10	Kamkuru 2	36⁰33’76.9E	1⁰68’89.2S	699	Cattle rearing.

Source [13]

2.2 Equipment and apparatus

Hand held Global positioning system (GPS) receiver (Map 410 Magellan) used to obtain coordinates of sites sampled, Mermmert oven, Fractional distiller used to distil all general-purpose grade solvents. Soxhlet set up used for extraction of soil samples. Separatory funnel used for solvent-solvent extraction, rotary evaporator for sample extracts reduction. Aluminium oxide chromatographic glass column used for the sample clean up. Shimadzu analytical weighing balance model number ATX224 was used to weigh the samples, BINDER E28#04-71528 oven used for moisture content determination, Mammoth laboratory oven used for drying glassware. A lab-line refrigerator was used for keeping the samples. A Hewlett-Packard Agilent Gas chromatography system 6890N equipped with Agilent Mass selective detector was used for quantifying pesticides residues levels in the sample extracts.

2.3 Chemicals and reagents

General Purpose Grade (GPR): hexane, dichloromethane and acetone were obtained from SCIELAB LTD, Kenya. High Performance liquid chromatography (HPLC) grade iso-octane, hexane and acetone were obtained from sigma Aldrich from their local supplier, Kobian Scientific Ltd. Analytical grade Aluminium oxide, and activated anhydrous Na2SO4, NaCl, K2HPO4, HCl, NaOH, copper powder was obtained from SCIELAB LTD, Kenya. Analytical grade pesticide standards (Amitraz, Cypermethrin and Deltamethrin) were purchased from Dr. Ehrenstorfer GmbH Company (Germany) from their local supplier Kobian Scientific Ltd in Nairobi. White sport nitrogen was obtained from Gas labs LTD, Nairobi. 99.999% pure helium gas was obtained from BOC Kenya LTD. Distilled Water was obtained at the physical chemistry laboratory, University of Nairobi.

2.4 Sample collection form homemade spray, water and soil

A reconnaissance tour was made in February 2018 prior to sample collection in company of local veterinary officer (Mr. Mulwa) for familiarity and consent. Thereafter sampling was conducted in the months of May (wet season) and November (dry season) 2018 respectively. Homemade cattle sprays were sampled from ten (10) willing livestock farmers randomly selected and requested to prepare acaricide sprays in their normal procedures. Quadruplet ready homemade

sprays were collected from each of the ten sampling sites. Samples were taken into 2.0 litre brown amber bottles before farmers sprayed their animals. For recovery, one of the quadruplet sample was injected with 10 ml of 100 mg/L of acaricide standard. Amber bottles used were earlier washed and rinsed with distilled water and dichloromethane and dried in a Mermmert oven overnight. Each of the samples was labelled and 100 grams NaCl added to dehydrate the bacteria that may degrade the acaricides. Samples were packaged in polyethene cool-box and transported to university of Nairobi pesticide analytical laboratory for analysis.

Water samples were collected from six (6) selected sampling sites along the southern Ewaso Ng'iro River adjacent to farmers spray sites (Figure 1). Water was collected by grab method into precleaned 2.5 L brown amber bottles. For recovery each of the water samples was injected with 10 ml of 100 mg/l of acaricide standard. For conservancy, 100 grams NaCl was added to each of the samples. They were labelled, packed and transported to the laboratory awaiting analysis.

Soil samples (0-30 cm plough layers) were sampled from the selected ten farmers spray sites. A soil core sample was excavated with a hoe and taken at 25 cm depth using clean stainless-steel shovel from five different points within the place where the cattle had been sprayed and approximately 200 g of each core scooped. They were carefully mixed in aluminum foil to make a composite sample. Quadruplet composite samples of 200 g from each site were collected. Soil sample was wrapped in an aluminum foil, labeled A for triplicate and B for quadruplet, packed in plastic container with lid and kept briefly in polyethene cool-box prior to transportation to the University of Nairobi pesticide analytical laboratory for analysis.

For field recoveries the samples labelled B, were placed in aluminum foil and injected with 4000 uL of 100 ppm of acaricide standard mixture from Dr. Ehrenstorfer GmbH Company Ltd (Germany). B samples were crammed the same as Lot A samples. At the workroom, portion of soil samples that was not injected with the standard were scooped for physico-chemical analysis the remaining was kept at -16 ^{o}C awaiting analysis, this was finished within two days.

2.5 Homemade cattle spray, River water and soil samples Extraction

Homemade spray samples were solvent-solvent extracted following EPA method 3510 (USEPA 1996). 500 mL of home cattle spray samples was poured into 1000 mL beaker, pH noted and 0.05 L of 0.2 M K2HPO4 buffer was introduced and pH noted, and then attuned through addition of drops of 0.1 N HCl or 0.1 M NaOH. The solution moved to 2 L separatory funnel and 100 g of activated NaCl added to help in salting out pesticide from aqueous layer to carbon-based layer. The combination was triple extracted by trembling with 30 mL purified methylene chloride and relaxed for fifteen minutes to improve separation. The extraction of the samples was performed in quadruplicate including the field recovery sample.

The organic layer extracts were transferred into 250 mL beaker, dried with Na2SO4 then 2000 µL of 2, 2, 4-trimethylpentane added, transferred into 250 ml round bottom flask and reduced to 2000 µL using rotatory evaporator. Reduced extracts were put into 10 mL glass vials with screw caps and refrigerated at - 4 °C awaiting clean- up.

River water samples were extracted through liquid-liquid extraction following EPA method 3510 (USEPA 1996). 500 mL water were moved into 1 L beaker, pH recorded and 0.05 L of 0.2 M K2HPO4 buffer was added, stirred, pH noted, and attuned by addition of drops of 0.1 N HCl or 0.1 M NaOH. The solution was then poured to 2 L separatory funnel and 100 g of activated NaCl added to help in salting out pesticide. The combination was triple extracted with 30 mL purified methylene chloride and relaxed for 900 seconds to improve separation into two phases. Extraction of the samples was performed in quadruplicate including the field recovery sample. The extracts were transferred into 250 mL beaker, dehydrated with Na2SO4 and 2 mL

of 2, 2, 4-trimethylpentane added. Extracts were transferred into 250 mL round bottom flask and reduced to 2 mL using rotatory evaporator. Reduced extracts were put into 10 mL glass vials with screw caps and refrigerated at - 4 °C awaiting clean- up.

Soil samples from freezer were defrosted for 12 hours and air desiccated. Soxhlet extraction of soil was done following EPA method 3540 [15]. Triplicate 20 g of every sample was dried with 60 g of anhydrous Na2SO4 and moved into Soxhlet cap, 50 mL of 0.1 ppm isodrin was introduced. 200 mL of acetone: hexane combination in proportion of 1:3 was transferred into 0.25 L round bottomed flask and the Soxhlet apparatus set up, the extraction was done for 16 hours. The extracts were reduced using LABCONCO rotary evaporator to around 2 ml, transferred into 10 mL glass vials with screw caps and kept in a fridge at - 4 °C awaiting clean- up and sulphur removal.

2.6 Homemade cattle spray, river water and soil samples clean up

Concentrated 3 mL of extract were cleaned through alumina chromatographic column packed in sequence with 1 gm activated sodium sulphate, 15 gm deactivated aluminium sulphate and 1 gm activated sodium sulphate pre-conditioned with 15 mL hexane. Extracts were each eluted with 165 mL hexane into a pre-cleaned 250 ml round bottomed flask. 2 mL of isooctane added and extract reduced to around 2 mL using a rotary evaporator. Concentrates were moved into a pre-weighed auto sample vial and reduced to 0.5 ml in a mild flow of nitrogen gas for GC-MS analysis.

Soil samples were put into 10 ml glass vials with screw caps and stored in a refrigerator at -4℃ awaiting Sulphur removal.

2.7 Soil Sulphur removal

1 gm of stimulated copper powder was introduced to each of soil extracts resulting in formation of copper (II) sulphide compound (black color). Compound was sieved through a crystal conduit crammed by glass wool and 2 gm of sodium sulphate. Glass funnel was conditioned by introducing 5 mL hexane and discarded. Sample was introduced into glass and removed with 20 mL of hexane into 250 ml flask and 2 mL isooctane (keeper) added. Sample extract was further reduced to 1 mL in a rotary evaporator and moved to a pre-weighed auto sample vial using Pasteur pipettes and further reduced to 0.5 mL under a mild flow of white spot nitrogen and stored in a refrigerator awaiting GC-MS analysis [16].

2.8 Quality assurance

The samples were injected with internal standard (isodrin) before extraction to help check on recovery and method efficiency. Quality control of laboratory reagents and blanks were done as well as sample analysis. The samples analysis was done in triplicates. Also, field reference samples, blanks which were anhydrous sodium sulphate and distilled water were used. The blanks were carried to and from the field during sampling to trace back any form of contamination if any. They were treated just like the samples.

2.9 Samples analysis and Quantification

Acaricides analysis in the samples was by the gas chromatography–mass spectrometry (GC–MS) on a 6890N GC instrument (Agilent, USA) equipped with a thermo scientific trace GOLD GC column (TG 5SILMS 30m X 0.25mm internal diameter X 0.25 µm coupled to an Agilent 5973 MS (USA). The mass spectrometer (MS) was operated in EI + mode in the resolution of >5000 in full scan mode. Injection was split less with volume of 1µL and temperature of 250 ºC with helium (99.999% pure) as carrier gas at 1 mL min-1. Oven temperature was maintained initially at 90 ºC for 1min, increased at 35 ºC min-1. to 185 ºC, then at 5 ºC min-1. to 190 ºC hold time was 5 minutes, at 10 ºC min-1. to 220 ºC withhold time of 5minutes, 25 ºC min-1. to 250 ºC hold time is 5 minutes.

In quantification, reference standard of the acaricide pesticides obtained from Dr. Ehrenstorfer GmbH Company (Germany) were used in various steps in the

analysis. Working reference standard solutions curves for amitraz, cypermethrin and deltamethrin were obtained in the range of 0.01-120 ppm. 1.0 µL of each reference standard solution was injected into GC–MS. The solution of the reference standard mixture was also injected to obtain the retention time.

The concentrations of acaricides pesticide residue levels in the samples were determined using a standard method involving use of reference standard calibration curve within laboratory reproducibility acceptability. The levels were gotten by interpolation from the graph which applies the straight-line equation.

2.9 Data Analysis

Data obtained on home spray and environmental residue levels of acaricides in soil were analyzed using Microsoft Excel software version 2010. The data was then presented as mean of triplicate analysis with standard deviation and represented in form of linear graphs and tables. Analysis of variance (ANOVA) was done at 95 % Confidence Interval to compare the means of pesticide residue levels in homemade cattle spray, water and soil.

III.RESULTS AND DISCUSSION

3.1 Limits of detection and Quantification of acaricides

The study was conducted to determine the residue levels of amitraz, cypermethrin and deltamethrin in homemade cattle spray that farmers use to spray their animals, water and soil in the dry and wet seasons. Amitraz had the highest limit of detection (LOD) at 0.034 ± 0.002 µg/L and limit of quantification (LOQ) of 0.340 ± 0.001 µg/L while Cypermethrin had the lowest limit of detection of 0.022 ± 0.001 µg/L. The limit of detection and quantification for the acaricides standards in water are given in Table 2.

Table 2 Limits of detection and Quantification of acaricide standards

Analyte	LOD (µg/L	LOQ (µg/L))
Amitraz	0.034±0.002	0.340±0.001
Cypermethrin	0.022±0.001	0.222±0.002
Deltamethrin	0.026±0.001	0.201±0.002

n = 6 mean ± standard deviation

3.2 Percentage recoveries of acaricides in Homemade cattle spray, water and Soil Samples

The recoveries for homemade cattle spray, water and soil are given in Table 3. All the recoveries were within the recommended range of 70-120% hence the concentrations of the pesticides were not corrected [17].

Table 3 Percentage Recoveries of acaricides in Homemade cattle spray, water and Soil Samples

Acaricides	(%) Homemade cattle sprays (µg L^{-1})	Percentage water (µg L^{-1})	Percentage soil (µg kg^{-1}, dw)
Amitraz	89.27±1.64	78.17±4.21	76.38±4.81
Cypermethrin	93.42±3.22	81.67±2.18	85.23±5.80
Deltamethrin	91.66±2.87	89.34±5.66	79.69±3.16

n = 6, mean ± standard deviation, DW = dry weight

3.3 Acaricides residue levels in Home cattle spray (µg/L) in dry and wet seasons

In Table 4 the results show that some farmers mix Amitraz, cypermethrin and deltamethrin [18]. The homemade spray in Site 1 dry season was a mixture of amitraz (11,620±120.1 µg/L) and deltamethrin (6,285±35.05 µg/L), Site 2 had cypermethrin (9,311±23.17 µg/L) and deltamethrin

(7,226±41.3 µg/L), while Site 3 had cypermethrin (11,972±74 µg/L) and deltamethrin (3,879±33.2 µg/L) respectively.

The farmers at Sites 2, 3, 4 and 5 did not use amitraz. Its residue levels were below detection limits (BDL) of 0.034±0.002 µg/L at these four sites. Farmers at Sites 6, 7, 8, 9 and 10 did not use both cypermethrin and deltamethrin as their concentrations were BDL of 0.022±0.001 µg/ L and 0.026±0.001 µg/L respectively (Table 4).

The levels of the acaricides in homemade cattle spray during the wet season were high at Site 3 (10,315±318.1 (µg/L) for cypermethrin and 4,781±125.8 (µg/L) deltamethrin respectively (Table 4). It can be deduced that in dry and wet seasons (Table 4) farmers do not vary their concentrations probably due to the quantity of rainfall which is spatial [13] and the overlap of seasons that tends to harbor similar pests.

Table 4 Acaricides residue levels in Home cattle spray (µg/L) in dry and wet seasons

Site/Acaricides	Amitraz (µg/L)	Cypermethrin (µg/L)	Deltamethrin (µg/L)
Dry wet			
1	11,620±120.1	≤0.022	6,285±35.05
2	≤0.034	9,311±23.17	7,226±41.3
3	≤0.034	11,972±74	3,879±33.2
4	≤0.034	3,834±80.2	≤0.026
5	≤0.034	11,586±62.1	12,298±82.1
6	7,814±61.4	≤0.022	≤0.026
7	11,196±98.2	≤0.022	≤0.026
8	3,884±25.3	≤0.022	≤0.026
9	5,682±41.3	≤0.022	≤0.026
10	12,236±14.54	≤0.022	≤0.026
Wet season			
1	5,430±96.10	≤0.022	≤0.026
2	6,658±35.3	8,975±103.7	≤0.026
3	≤0.034	10,315±318.1	4,781±125.8
4	6,978±36.8	≤0.022	≤0.026
5	11,634±107.2	≤0.022	≤0.026
6	8,695±49.5	≤0.022	≤0.026
7	≤0.034	10,383±562	≤0.026
8	6,632±79.9	≤0.022	≤0.026
9	6,876±105.3	≤0.022	≤0.026
10	9,876±634.2	≤0.022	≤0.026

n = 6, mean ± standard deviation

3.4 Acaricides residue levels in soil samples (µg/kg, dw) in the dry and wet seasons

The analyses of loam soil samples from the ten sites in dry and wet seasons gave the values of the acaricides residue levels as shown in Table 5. The residue levels of acaricides were analyzed in soils

in the dry and wet seasons (Table 5). The farms in Site 1 and 2 were found to use amitraz and deltamethrin while those in Sites 3 and 5 use cypermethrin (8,654+141.2 µg/kg) and deltamethrin (1,341+58.06 µg/kg) respectively with exception of site 4 who use only cypermethrin (3,041+33.15 µg/kg). These remaining in Sites 6, 7, 8, 9 and 10, use amitraz in controlling pests on their livestock. Upon change of season to wet, farmers at Sites 1, 5, 6, 8, and 9 use amitraz and cypermethrin, at 3 use amitraz and deltamethrin while at 4, 7 and 10 they use cypermethrin only (Table 5).

Table 5 Acaricides residue levels in soil (µg/kg, dw) in dry and wet season

Site/Acaricide	Amitraz (µg/kg)	Cypermethrin (µg/kg)	Deltamethrin (µg/kg)
Dry season			
1	6,530±27.2	≤0.022	5,626±103.1
2	5,320±64.1	≤0.022	4,986±87.1
3	≤0.034	8,654±141.2	1,341±58.06
4	≤0.034	3,041±33.15	≤0.026
5	≤0.034	8,423±79.2	8,167±16.4
6	6,412±65.1	≤0.022	≤0.026
7	10,641±144.2	≤0.022	≤0.026
8	1,970±91.3	≤0.022	≤0.026
9	3,129±98.7	≤0.022	≤0.026
10	6,546±120.75	≤0.022	≤0.026
Wet season			
1	4,230±43.1	≤0.022	≤0.026
2	5,177±122.4	8,633±179.1	≤0.026
3	7,905±184.2	≤0.022	2,367±76.9
4	≤0.034	4,832±86.7	≤0.026
5	4,832±86.7	≤0.022	≤0.026
6	6,194±120.6	≤0.022	≤0.026
7	≤0.034	8,694±146.9	≤0.026
8	3,875±97.3	≤0.022	≤0.026
9	4,691±75.3	≤0.022	≤0.026
10	≤0.034	,063±146.2	≤0.026

n = 6 mean ± standard deviation

From the two seasons, most farmers are observed to mix either deltamethrin with cypermethrin with majority giving a preference to amitraz as the main acaricide. The comparison of the acaricide values in Tables 5 reveals that amitraz residue levels are high in the dry than wet seasons in spite the use of cypermethrin and deltamethrin. This could be attributed to the ease of solubility of amitraz compared to cypermethrin and deltamethrin thus hastening their percolation to lower soil layers [19].

All the acaricides used in homemade cattle sprays in dry season were detected in the soils as residues except for Site 2 which showed amitraz residues levels in soil in dry season that had not been sprayed. This could mean that the acaricide had previously been sprayed based on varying spray days. Similarly, homemade cattle spray at Site

2 had cypermethrin which was below detection levels in the soil at that site in dry season, probably due to high evaporation rates. Results in both seasons lead to a deduction that study area have higher preference of using amitraz than cypermethrin and deltamethrin. It concurs with a study by [10] which reported a significant higher number of farmers preferring using amitraz group of acaricides due to its effectiveness [20].

The residue levels of the acaricides in the water samples from six sites from Ewaso Nyiro River which were adjacent to the spraying homes (Figure 1) were below detection levels in all the river samples in both the dry and wet seasons. This low amount of the acaricides in water can be attributed to extreme instability of amitraz, cypermethrin and deltamethrin in aquatic ecosystems [20] and further the low levels in wet season could be due to the nature of rainfall that is spatial allowing minimal leaching of acaricides to newer areas.

Other researchers have detected higher pesticides concentrations during the wet seasons than during the dry seasons due to leaching through water ways like Nyando River [19]. The phenomenon also implies that homemade cattle sprays have not affected the environment significantly.

IV.CONCLUSION

The most common and available acaricide ai in the sub county were amidines and synthetic pyrethroids comprising of amitraz, cypermethrin and deltamethrin. The concentration of the cattle homemade spray ranged from 3.88 ± 0.001 to 12.2±1.45 µg/L for amitraz, 3.83 ± 0.08 to 11.97 ± 0.74 µg/L for cypermethrin and 3.87 ± 0.33 to 12.29 ± 0.82 µg/L for deltamethrin. Farmers claimed that this mixing of acaricides increased the efficacy of the treatment [18]

The concentration of acaricides were below detection limit in the river water samples. From this study, it is revealed that during the dry and wet seasons, river do not receive any significant acaricide residues from sources of application because of lack of or minimal runoff due to varying rainfall patterns [21].

The analysis revealed that homemade cattle sprays in the sub-county had low levels of amitraz, cypermethrin and deltamethrin than those recommended by the manufacturers at 50,000-400,000 µg/L indicating that the acaricides were over diluted leading to the observed tick re-occurrence. Successful acaricides use for tick control relies on farmers' knowledge, acaricides chemical composition and correct following of manufacturers application instructions. This involve proper mixing ratios of acaricides with water to obtain the recommended active ingredients (ai) level for effective tick control [18].

V. Disclosure Statement

The authors declared no conflict of interest.

VI.Acknowledgement

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