

# Evaluation of risk factors and the use of tick control products to prevent infestation with *Rhipicephalus sanguineus* and tick fever in dogs on Curaçao.

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## Abstract

In this study the use of tick control products on dogs and pest control products in the environment and their efficacy against *Rhipicephalus sanguineus* on the island of Curaçao is evaluated. Ticks and blood samples collected from dogs diagnosed with tick fever in veterinary clinics on Curaçao were examined for the presence of *Ehrlichia spp.*, *Babesia spp.*, *Anaplasma spp.* and *Theileria spp.*. All collected ticks were identified as *Rhipicephalus sanguineus*. None of the ticks were positive when tested with reverse line blot. By testing the blood samples not only *Ehrlichia canis* was found (10,5%) but also *Babesia vogeli* (14,5%).

92% of the respondents (dog owners visiting veterinary clinics) was using tick control products on their dogs. The most used tick control products on dogs are Frontline<sup>®</sup> spot on (50% of all used products), Frontline<sup>®</sup> spray (39%) and Preventic<sup>®</sup> collar (24%). About half of the users of tick control products (52%) is using a combination of two or more products. Most used combinations are Frontline<sup>®</sup> spot on with a Preventic<sup>®</sup> collar and Frontline<sup>®</sup> spot on with Frontline<sup>®</sup> spray, used by respectively 14% and 10% of all respondents using tick control products. Almost half of the products (49%) were used incorrectly due to incorrect application or incorrect frequency.

Dogs treated with tick control products had a median number of 2 ticks versus 18 ticks on dogs not treated with tick control products.

The most effective products according to this study were Frontline<sup>®</sup> spray, Preventic<sup>®</sup> collar, Ovitrol<sup>®</sup> plus spray, Frontline<sup>®</sup> Spot-on and powders with median numbers of less than or equal to three ticks.

The median numbers of ticks found on the dogs per product did not correlate with the percentages of users being satisfied with the products.

Almost half of the respondents 49% was taking pest control measures in home, in the garden or both. Using pest control in the garden and in home seemed to be effective against tick infestations on dogs.

Dogs housed mainly in home and in the garden had the lowest median number of ticks (1), followed by housed in home (2), in the garden (8) and in a kennel (10).

Dogs living mainly in home and in home and in the garden were more often treated correctly with tick control products compared to dogs living mainly in the garden or in a kennel.

From dogs with access to the garden a soil type of sand and gravel/diabase led to the highest median tick numbers on the dogs.

## 1. Introduction

Ticks are responsible for a major part of health problems in dogs on the island of Curaçao. Many dogs are diagnosed with tick fever and treated for this disease with doxycycline.

In prior research the only tick found on dogs on this island was *Rhipicephalus sanguineus*, also known as the Brown dog tick. (Klarenbeek, 2010; Krogt van der, 2010)

Ticks cause problems due to damage as a result of their feeding behavior and indirectly by acting as a vector for various pathogens. (Dantas-Torres *et al.*, 2008)

*R. sanguineus* is known as a vector for several pathogens including *Ehrlichia canis*, *Babesia canis vogeli* and *Hepatozoon canis*. (Yabsley *et al.*, 2008)

*R. sanguineus* belongs to the Ixodid ticks. These ticks need three blood meals to complete a lifecycle. (Lord, 2008) *R. sanguineus* ticks have four stages in their development; egg, larva, nymph and adult. (Stich *et al.*, 2008)

The tick is a three-host tick, therefore the tick has to leave the host after a blood meal to molt and develop between the different life stages. (Dantas-Torres, 2010; Lord, 2008)

*R. sanguineus* prefers to feed on dogs although does sometimes feed on other mammals including rodents and humans. Unlike many other ticks *R. sanguineus* can complete the entire life cycle indoors. (Dantas-Torres, 2010; Lord, 2008; Uspensky *et al.*, 2002)

Due to this characteristic this tick is more likely to survive in colder climates by living indoors.

The *R. sanguineus* ticks have preferred attachment sites on the dog, they prefer to feed on the head (mainly the ears), between the toes, the axilla, the back and the inguinal region.

The different stages are unequally divided between these preferred sites. Adult ticks are mainly found on places that are difficult for the dog to remove them like on the ears, while the immature stages are mostly found on the lower parts of the body. (Dantas-Torres, 2010; Dantas-Torres, 2011)

Six to twenty-three days after oviposition eggs hatch, and larvae are coming out. The larvae search for a host and feed on the first host for three to ten days. After feeding they drop off the host and molt to develop into the next stage as a nymph in approximately two weeks time. The nymphs will search for a second host to feed again for three to eleven days. When fed, the nymph will fall off the second host and molts into an adult tick what takes from 9 to 47 days. The adult ticks search for a third host where they will have their last blood meal. (Dantas-Torres, 2008)

An adult female will wait to become fully engorged until after mating. (Dantas-Torres, 2010) Adult female ticks feed for five to twenty-one days. (Dantas-Torres, 2008) After this blood meal the adult female will drop off the host and lays her eggs after a pre-oviposition period varying from three days to some weeks. (Dantas-Torres, 2010)

Depending on the size of the female tick and the amount of blood ingested she can lay up to 5000 eggs which will hatch after two to five weeks. (Lord, 2008)

The three hosts do not necessarily have to be three different dogs. So it is possible for the tick to feed more than once on the same dog to complete the life cycle. (Lord, 2008)

Oviposition usually takes place near a host's resting place in a sheltered place like in cracks and crevices in walls and between rocks protected against predators. (Dantas-Torres, 2010)

The oviposition takes about sixteen to eighteen days after which the female dies. (Dantas-Torres, 2008)

The temperature is an important factor in development. By higher temperatures the time needed for feeding and development between the stages is shorter than in colder conditions. In optimal conditions the life cycle can be completed in a bit over two months but will take longer in colder temperatures and when hosts are difficult to find. When necessary every stage can survive for months without feeding. (Dantas-Torres, 2008; Lord, 2008)

The unfed larvae can survive for about eight months, the nymphs for six months and the adults for nineteen months. (Dantas-Torres, 2008)

Tick borne pathogens can be transmitted transstadially and/or transovarially.

For a *R. sanguineus* tick to transmit *Ehrlichia spp.* to a dog the tick has to be infected earlier in a larval or nymph stage when feeding on another infected host, since *Ehrlichia spp.* can only be transmitted transstadially. (Doubier *et al.*, 2010)

*B. canis vogeli* can maintain in a tick population without the presence of an infected dog because *B. canis vogeli* can be passed by transovarially transmission to the next tick generation. (Trap *et al.*, 2006)

*E. canis* can lead to CME (Canine Monocytic Ehrlichiosis) in all dog breeds. This disease can present itself in three phases; an acute, subclinical and chronic phase. (Stich *et al.*, 2008; Harrus *et al.*, 1998)

Possible present signs in the acute phase are; fever, depression, lethargy, anorexia, lymphadenopathy, conjunctivitis, multiple skin hemorrhage and epistaxis. (Rungsipipat *et al.*, 2010)

Dogs surviving the acute phase can recover spontaneously or enter an subclinical phase, which can last for years. After the subclinical phase, some dogs will enter the chronic phase. (Harrus *et al.*, 1998)

During the subclinical phase these dogs can be recognized by having a mild thrombocytopenia combined with persistently high antibody titers against *E. canis*. (Waner *et al.*, 1997)

In a study with 19 natural infected dogs with chronic ehrlichiosis by Mylonakis *et al.* in 2004, this phase was clinically characterized by anorexia, depression, and hemorrhagic tendencies. Common hematologic findings were; pancytopenia, hypoalbuminemia and increased serum alanine aminotransferase. (Mylonakis *et al.*, 2004)

*R. sanguineus* is able to transmit rickettsial diseases to humans like Mediterranean spotted fever and Rocky Mountain spotted fever respectively caused by *R. conorii* and *R. rickettsii*. (Parola *et al.*, 2008)

It is still uncertain whether *E. canis* can cause disease in humans. There are findings only suggesting *E. canis* might be transmitted to and cause disease in humans. Further research is needed to determine the pathogenic role of *E. canis* in humans. (Doudier *et al.*, 2010; Stich *et al.*, 2008)

The *Babesia* species *Babesia canis*, *Babesia vogeli* and *Babesia gibsoni* are known to cause natural infections in dogs. (Amuta *et al.*, 2010)

*Babesia canis vogeli* is the least pathogenic and causes moderate and often subclinical disease. (Matjila, 2004; Cacciò *et al.*, 2002)

*Babesia canis vogeli* is found in the USA, Japan, France, Australia, South Africa and Brazil. (Passos *et al.* 2005; Schoeman, 2010)

No prior research has been done to investigate the presence of this pathogen on the island of Curaçao. *Babesia canis vogeli* is suspected to be on Curaçao because of the presence of its vector *R. sanguineus* and dogs diagnosed with Ehrlichiosis which were not getting better without combined treatment with imidocarb dipropionate against *Babesia spp.*.

## Aim of this study

One goal of this study is to evaluate the use of tick control products to gain knowledge about which products are used, the place of buying, the effect and the way of use. The results may lead to a better advice for owners of dogs about the use of tick control products.

Another goal of this study is to determine how many ticks on dogs diagnosed with tick fever are positive for the causative pathogens using PCR and reverse line blot for detecting *Ehrlichia canis* and *Babesia spp.* in the ticks and in the blood samples as well.

Import of dogs and travelling with dogs to Mediterranean regions seems to increase the risk of infection with tick born diseases. (Menn *et al.*, 2010)

Knowledge about ehrlichiosis is valuable for the Netherlands because of introduction of dogs with *Ehrlichia canis* infections. Mostly these dogs have been abroad in a country where the disease is endemic. Nowadays infections have also been reported in dogs which have not travelled to endemic areas. (Blaauw, 2008)

Also the vector of *Ehrlichia canis*, the *R. sanguineus* tick, is found in the Netherlands on dogs without a history of being abroad. Probably these ticks infested these dogs by direct or indirect contact with dogs that have been in endemic areas. (Bodaan *et al.*, 2007)

Next to going on holidays with dogs in endemic areas and importing dogs from these areas, the expansion of the habitat from the tick *R. sanguineus* may form a threat for dogs in the Netherlands by consequently increasing the prevalence of *Ehrlichia canis* infections in the future.

Data from tick research in France suggests the habitat of *R. sanguineus* in Europe has tended to move northwards. Geographical distribution of ticks can be affected by climate changes. (Beugnet *et al.* 2009)

Expansion of the habitat of *R. sanguineus* to the Netherlands in the future could be a reasonable possibility. According to Gray *et al.* an increase of the mean temperature from April to September of approximately 2-3 °C might result in the establishment of populations of the tick in northern temperate Europe. (Gray *et al.*, 2009)

Regardless to warmer weather leading to an expansion of the habitat of *R. sanguineus*, warmer weather also seems to have influence on the aggressiveness of *R. sanguineus* to humans. Human affinity of *R. sanguineus* is increased by warmer temperatures. (Parola *et al.*, 2008)

## 2. Materials & Methods

At random 118 dog owners visiting a veterinary clinic were questioned following a question list (Appendix I). Six veterinary clinics on Curaçao were participating in this research. When an owner of a dog entered the waiting room in the clinic he/she was asked to answer some questions for this study. The questioner noted the present date, age, sex and breed of the dog. Next the type and color of the coat were determined by the researcher. For this study the owner was further questioned about being familiar with tick fever (karpattenziekte), Ehrlichiosis and Babesiosis and if the dog had a history including those diseases. The participants were further questioned about the use of tick control products. They were asked about which tick control products they use on the dogs brought to the clinic, the place of buying, how frequent they use the products, the place of application on the body of the dog, in which quantity and at last if they were satisfied about the used products. The manner of application and the frequency of using the products were judged using the instructions given by the manufacturers in the user manuals. (Appendix II)

The respondents were also asked if they use pest control only in the garden, only in the house or both. When using pest control products the clients were asked what products they use.

To estimate the number of ticks that are usually found on the dog, the owners were asked about the frequency of checking the dog for ticks and the number of ticks they find by checking.

The owners of dogs were asked if the dogs were living mainly in the house, in the house and in the garden or living mainly in a kennel. When living in a garden they were asked for the type of soil in the garden; concrete, gravel/diabase, earth, sand and/or grass. At last the owners were asked if they have taken the dog abroad.

To determine the quantity of ticks carrying *Ehrlichia canis* and/or *Babesia spp.* on with tick fever diagnosed dogs, a maximum of 10 ticks was collected from dogs diagnosed with tick fever by the researchers, the veterinarians or assistants in the participating veterinary clinics. Due to lack of time not all veterinarians were able to collect ticks from all dogs for this research.

The collected ticks were sent to Utrecht Centre for Tick-Borne diseases, where they were identified and foregone by DNA-extraction tested for the presence of *Ehrlichia spp.*, *Babesia spp.*, *Anaplasma spp.* and *Theileria spp.*.

To determine the number of dogs by which *Ehrlichia canis* can be detected with PCR and reverse line blot, blood samples were collected from dogs diagnosed with ehrlichiosis by a veterinarian. The dogs were diagnosed based on clinical signs in combination with low trombocyt counts measured with IDEXX QBC Vet Autoread and/or a for *Ehrlichia* positive Snap<sup>®</sup>4Dx<sup>®</sup> test.

The samples were modified using a NucleoSpin<sup>®</sup> Tissue kit (Macherey-Nagel) to gain the DNA-extractions. The DNA-extractions were stored at a temperature of -18 degrees and send by airmail to the Utrecht Centre of Tick-Borne Diseases. The extractions were tested in the laboratories of Utrecht for the presence of *Ehrlichia canis* and *Babesia spp.* using PCR and reverse line blot.

### 3. Results

#### 3.1 TEST GROUP

At random 118 dog owners were questioned in the veterinary clinics. Following the answers of the respondents they owned 2,74 dog per household.

The mean age in years of the dogs brought to the clinic was 3.60. 53% was female and 47% was male. 66% was crossbred. The most popular breed is the Chihuahua (a quarter of all true-bred dogs).

26% of the dogs had a dark coat (black or brown) 46% light (white or beige) and 28% had a spotted coat. Coat length was short, intermediate and long in respectively 72%, 18% and 10% of the dogs.

86% of the questioned owners was familiar with tick fever (named “karpattenziekte” in the local language). 22 (19%) of the dogs visiting the clinic had a history of tick fever, 21 (18%) had tick fever at the moment of the interview and one dog (1%) had both a history of tick fever and was again diagnosed with the disease during the consult on the day the owner was questioned.

7 dogs (6%) had been taken abroad. Popular destinations were non endemic areas like the Netherlands and different North American countries. 9 dogs were born in non endemic areas and all these dogs had a history of tick fever.

#### 3.2 TICKS AND BLOOD SAMPLES

A maximum of 10 ticks was collected from dogs diagnosed with tick fever. The researchers were able to collect ticks from 33 dogs which resulted in a total number of 129 collected ticks from dogs diagnosed with tick fever. All ticks found belong to the species *Rhipicephalus sanguineus*.

<i>Rhipicephalus sanguineus</i> stage	♂ adult	♀ adult	Undetermined adult	Nymph	Larvae	Total
Number	58	55	4	12	0	129
Percentage	45	43	3	9	0	100%
Percentage of determined ticks	46	44				

**Tabel 1: results of determination**

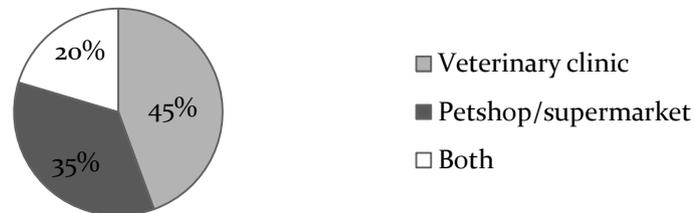
The sexratio of the adult ticks is 46:44% male:female (table 1). A few collected ticks were too damaged or too polluted with blood or eggs to determine by sex.

None of the ticks were positive when tested with PCR techniques for *Ehrlichia spp*, *Babesia spp*, *Anaplasma spp*. or *Theileria spp.* (Luijten, 2011)

Blood samples were collected from 76 dogs directly after being diagnosed with tick fever by a veterinarian. Of the blood samples tested with RLB 10,5% tested positive for *E.canis*, 14,5 % for *B.vogeli* and 1% for both pathogens (Mooij, 2011)

### 3.3 TICK CONTROL PRODUCTS

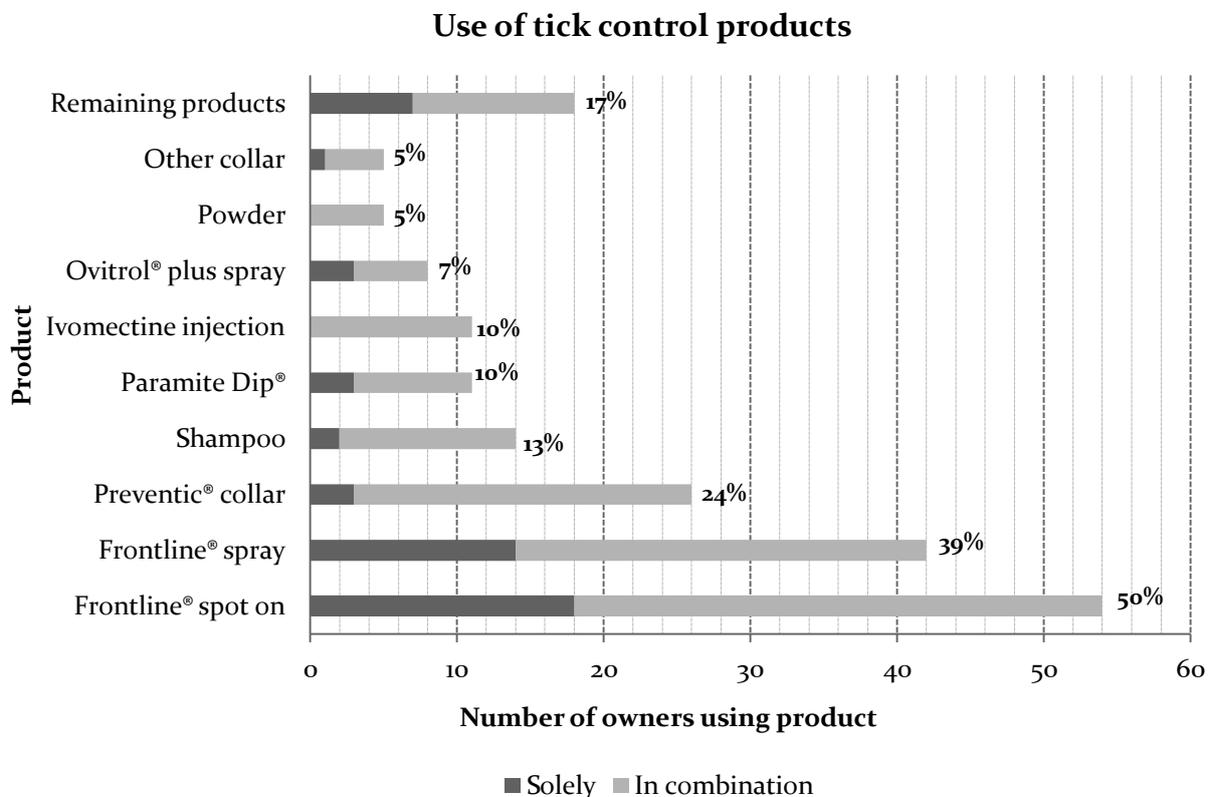
#### 3.3.1 Place of buying



Graph 1 place of buying tick control products

According to the answers of the questioned dog owners 92% (108 out of 118) of the questioned people is using tick control products. 45% of them is buying the products only in the veterinary clinic, 35% in a petshop or supermarket and the remaining 20% visits both categories (see graph 1).

#### 3.3.2 Use of tick control products

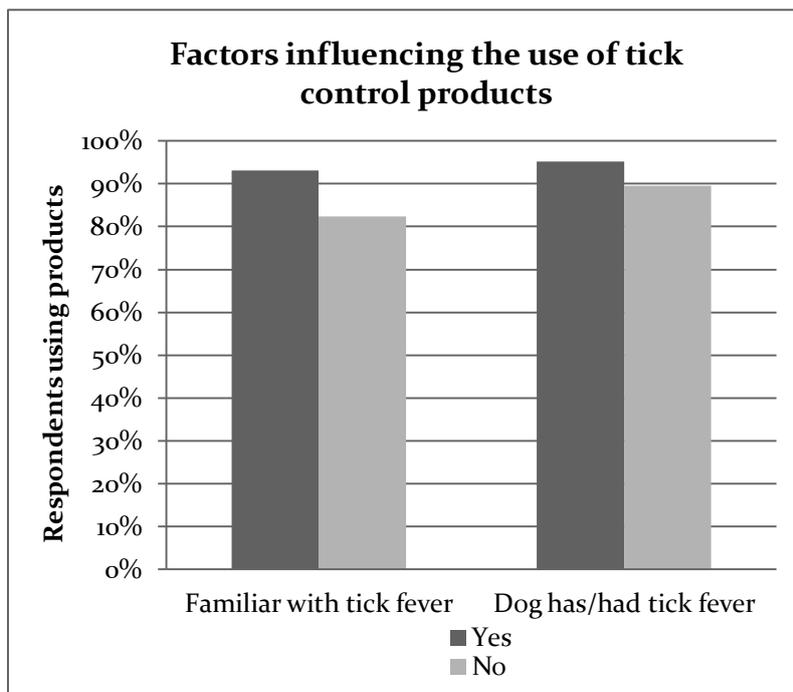


Graph 2 gives the number of used products by the questioned dog owners to prevent ticks on their dogs. A distinction is made between owners using a product solely and owners who combine the product with other products. The given percentages represent the use of the corresponding products by owners taking preventive measures against ticks on their dogs.

The categories of tick control products mentioned in graph 2 are used in 31 different combinations.

Exclusive of the category “remaining” in total 176 products are used by the questioned people. Frontline<sup>®</sup> spot on (50%) is the most used product for tick control, followed by Frontline<sup>®</sup> spray (39%), Preventic<sup>®</sup> collar (24%), shampoos of different brands (13%), Paramite<sup>®</sup> Dip (10%), Ivomectin<sup>®</sup> injection (10%), Ovitrol<sup>®</sup> Plus spray (7%), powder (5%) and other collars (5%). The category “remaining” consists of various products and measures used with the purpose to control ticks sometimes with but mainly without a proven working ingredient against ticks like feeding the dog with aloe, honey or garlic, washing with seawater, covering the coat with kalabas or aloe and using pyrantel (deworming product).

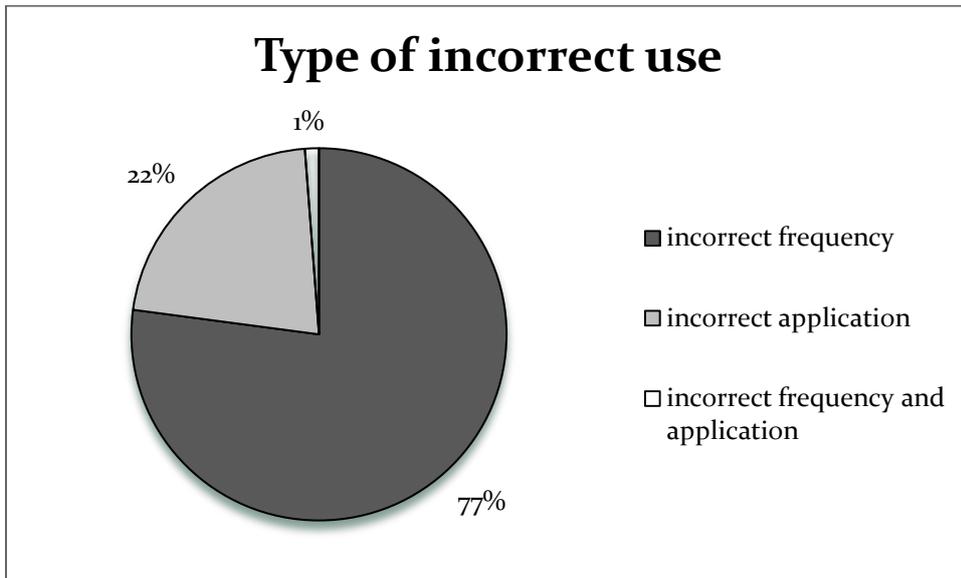
A small majority of the users of tick control products, 52%, is using a combination of more than one product. Most used combinations are Frontline<sup>®</sup> spot on with a Preventic<sup>®</sup> collar and Frontline<sup>®</sup> spot on with Frontline<sup>®</sup> spray, used by respectively 14% and 10% of all respondents using tick control products.



Graph 3 gives the percentages of respondents using tick control products on the dog, for dog owners who are and are not familiar with tick fever and for owners with dogs with and without a history of tick fever.

Graph 3 shows that a higher percentage of people who are familiar with tick fever (93%) is using tick control products compared with people who are unfamiliar with the disease (82%). More respondents (6%) who own a dog with a history of tick fever are using tick control products in comparison with respondents who own dogs without a history of the disease.

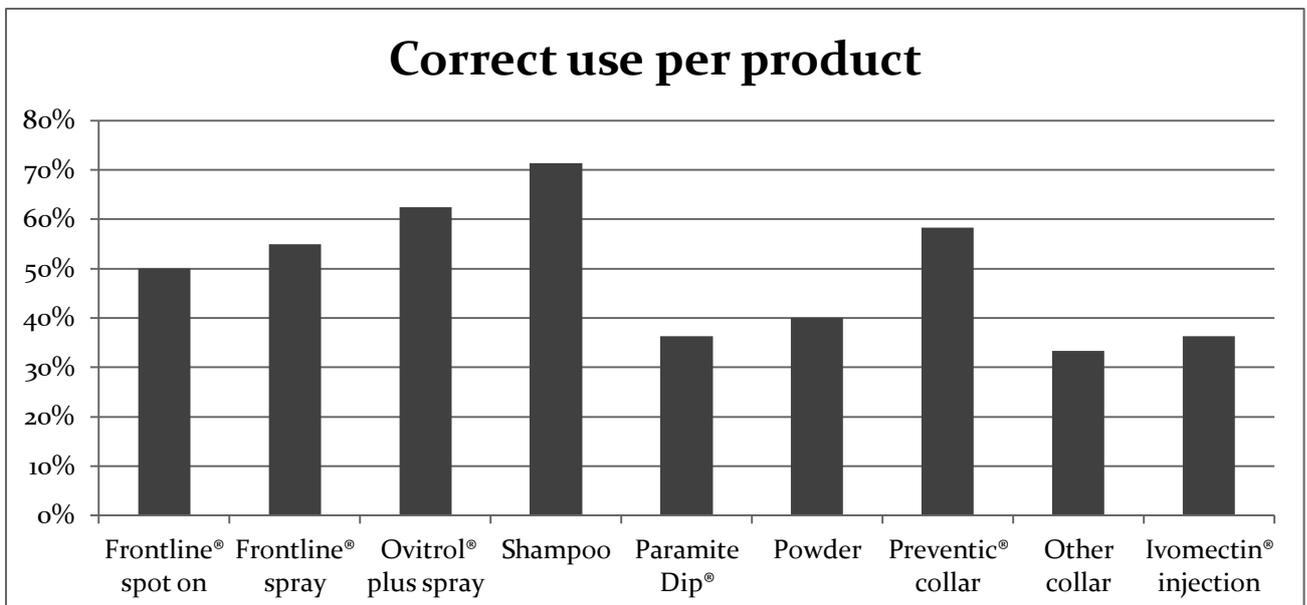
### 3.3.3 Correctness of use



Graph 4: reasons for incorrect use of tick control products.

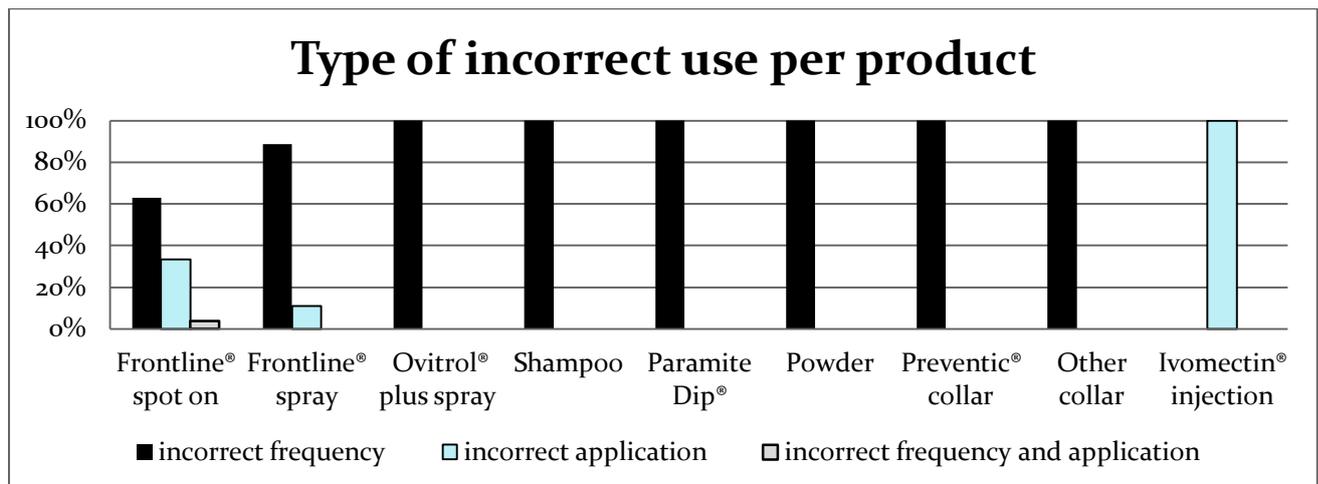
The frequency and the way of application of tick control products are compared with the instruction given by the manufacturers.

According to the answers of the dog owners 51% of the used products are being used according to the manufacturer's instructions. The remaining 49% was used incorrectly because of failing in using the product frequently enough (77%), because of faulty application of the product (22%) or both (1%) (see graph 4).



Graph 5: percentage of correct use per tick control product

At least 50% of the respondents used the products Frontline<sup>®</sup> Spot on, Frontline<sup>®</sup> spray, Preventic<sup>®</sup> collar, Ovitrol<sup>®</sup> plus spray and shampoo correctly. Less than 50% correctly used products are Paramite<sup>®</sup> Dip, Powder, Ivomectin<sup>®</sup> injection and other collars (see graph 5).



**Graph 6** Type of incorrect use per tick control product

Ovitrol<sup>®</sup> plus spray, shampoos, Paramite<sup>®</sup> dip, powders and collars are only used incorrectly because of mistakes in the used frequency. Incorrect use of Frontline<sup>®</sup> spot on and Frontline<sup>®</sup> spray were a result of both mistakes in frequency and application (see graph 6).

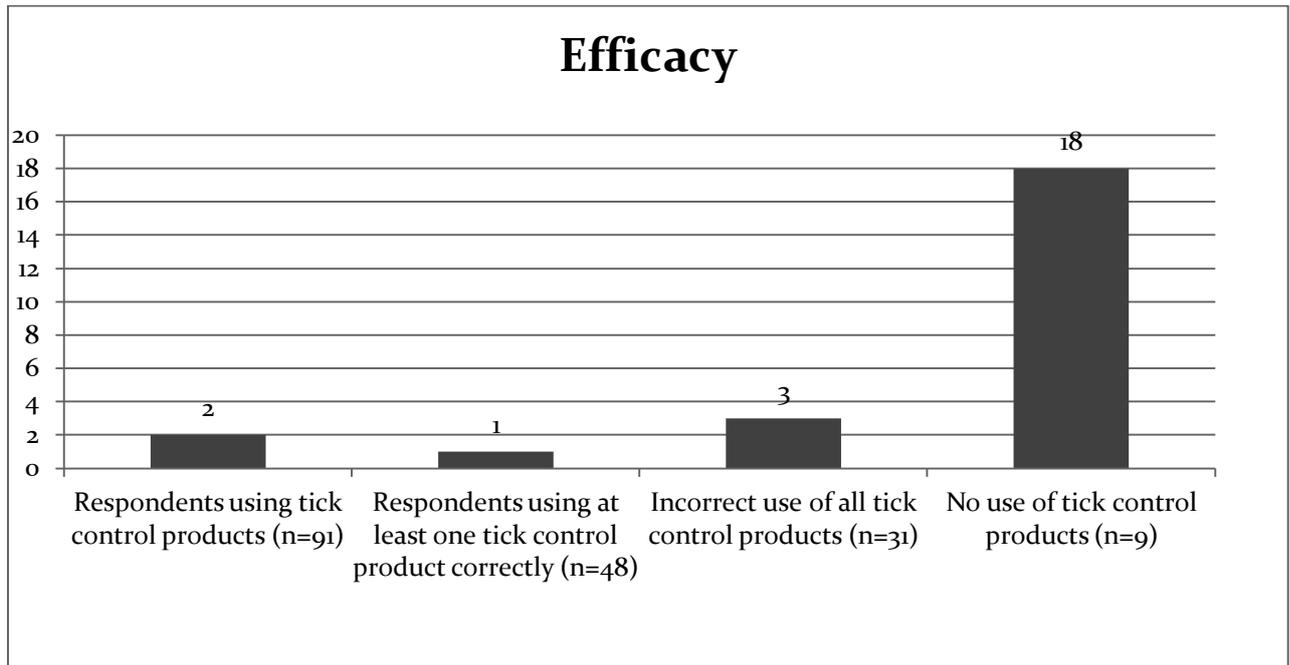
The use of Ivomectin<sup>®</sup> injections is not judged for the used frequency since there is no user manual available for the use on dogs because this product is actually produced to treat cattle. Sometimes veterinarians on Curaçao use Ivomectin injections 1ml per 20kg subcutaneous (M.M. Klarenbeek, 2010). When a dog has a severe high number of ticks the Ivomectin injection is used. In milder cases the use of registered tick control products is preferred.

Wrong application of Ivomectin<sup>®</sup> injections is due to respondents not consulting a veterinarian but instead giving their dogs the injections themselves after buying the product in a petshop. The dreaded consequences of injections given by untrained owners are injuries by misplaced injections and overdoses.

The cause for wrong application of both Frontline<sup>®</sup> spot on and Frontline<sup>®</sup> spray was mostly unawareness of the owners about the comment in the manual not to wash or let the dog swim 2 days before up to and including 2 days after application of the product. By using Frontline<sup>®</sup> spot on the owners also made mistakes in the place of application. Instead of application between the shoulder blades some owners apply the product over the whole spine and/or neck, partly between the toes or on the ears. Some of these owners told to be aware of the prescribed place of application between the shoulder blades but do not trust the product to spread by itself over the whole body.

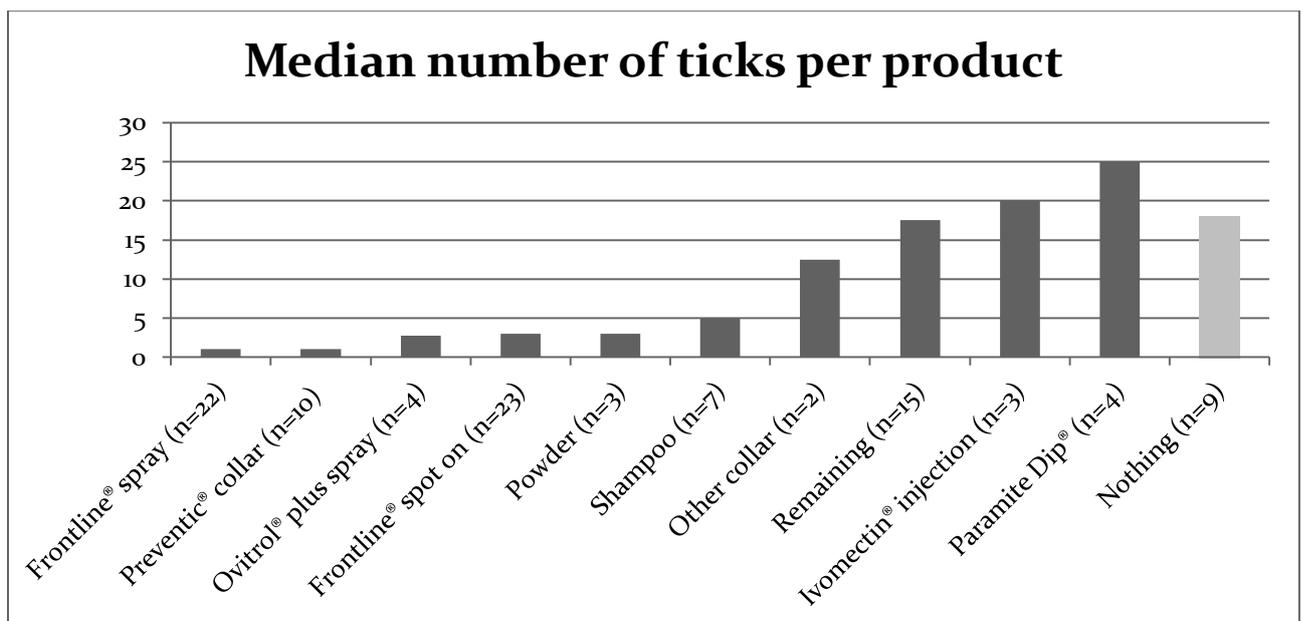
Many owners fail in applying the product frequently enough. Instead of following the manual of the manufacturer, they are using the products when detecting ticks or more ticks than usual on their dog(s).

### 3.3.4. Efficacy



**Graph 7: median numbers of ticks given for dogs treated with tick control products, dogs treated correctly and incorrectly with tick control products and for dogs that were not treated with tick control products. The n numbers describe the number of respondents per category corrected for dog owners that do not count ticks.**

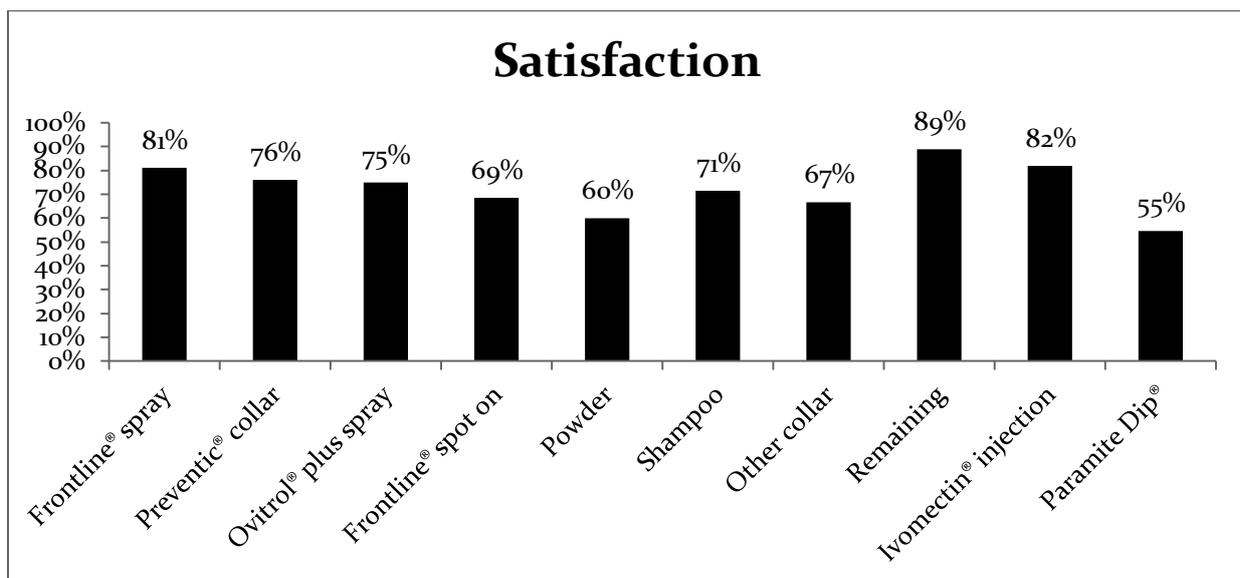
Graph 7 shows lower median tick numbers on dogs belonging to respondents who do use tick control products (2) compared with respondents who do not use tick control products (18 ticks per dog). Correct use of at least one tick control product led to a median tick number of 1 and incorrect use of all used tick control products led to a median tick number of 3 ticks.



**Graph 8: median number of ticks per product ranged from the lowest to the highest median number. On the right the median number is given for ticks found on dogs not treated with tick control products. The median numbers of ticks are calculated by using the numbers of ticks found in one week time by the dog owners. The n numbers describe the number of products per category corrected for incorrect use and dog owners that do not count ticks.**

Graph 8 gives the median number of ticks found on dogs treated with different tick control products. The median numbers of ticks on dogs per product is determined exclusive of numbers of ticks found on dogs treated incorrectly.

Frontline® spray, Preventic® collar, Ovitrol® plus spray, Frontline® spot on and powder have a median number of three or less ticks. Shampoo resulted in a median number of 5 ticks after which a gap follows with respectively 12,5 and 17,5 ticks found on dogs treated with other collars and remaining products and measures. For treatment with Ivomectin® injection and Paramite® Dip higher median numbers of ticks are found in comparison to dogs not treated with tick control products.



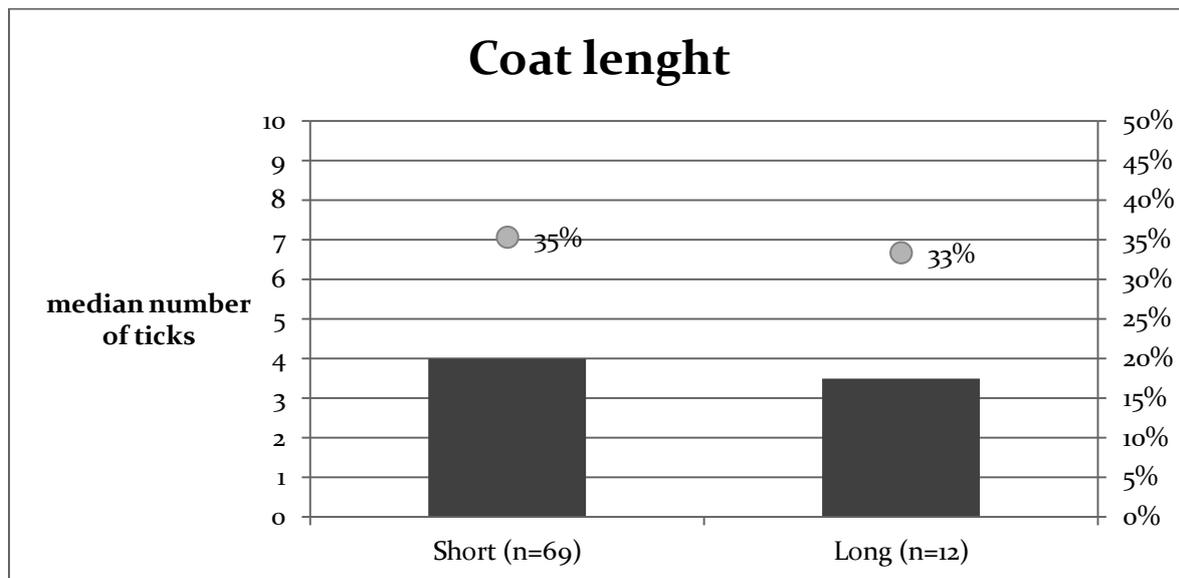
**Graph 9: percentage of satisfied users for different tick control products.**

Graph 9 shows the percentage of users being satisfied with the tick control products. The products are displayed in the same order as graph 8, from lowest median number of ticks to the highest median number found on the dogs.

The median number of ticks does not completely correspond with the percentage for satisfied users.

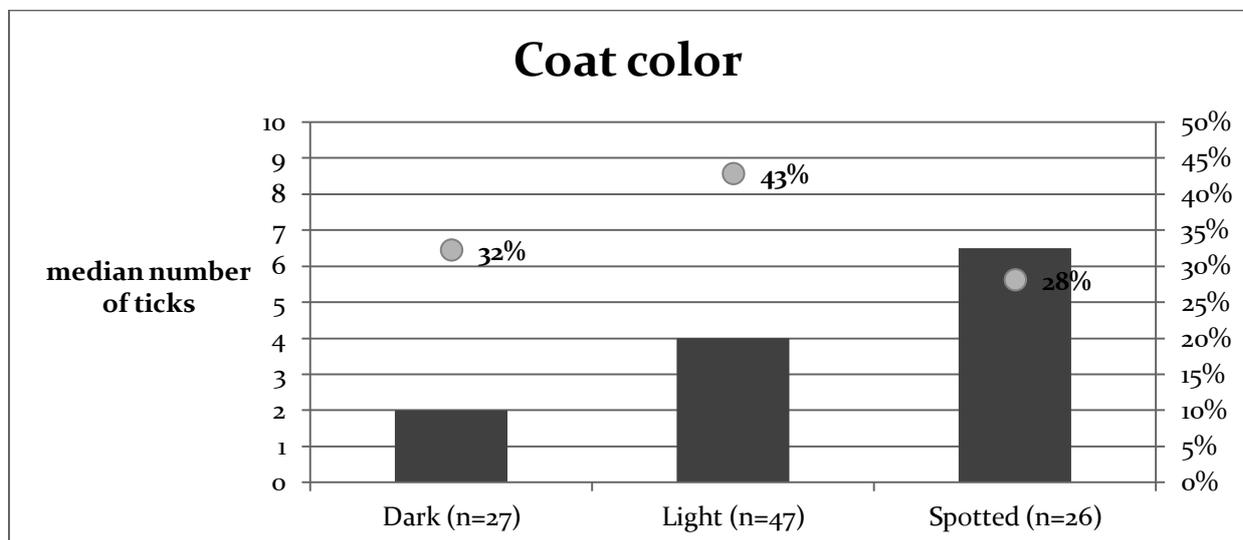
Top five most common reasons for not being satisfied were “dog did get tick fever anyway”, “still finding ticks on the dog”, “I had a better working product but this product is not available in the shops anymore”, “the products are too expensive” and especially by using Frontline “ticks are not falling off immediately”.

### 3.4 INFLUENCE OF INDIVIDUAL CHARACTERISTICS



Graph 10: in this graph different coat lengths are compared with the median number of ticks found on dogs and with having a history of tick fever. The columns refer to the median number of ticks. The dots refer to the percentage of dogs having a history with tick fever. The median numbers of ticks are calculated by using the numbers of ticks found in one week time by the dog owners. The n numbers displays the number of products per category corrected for dog owners that do not count ticks.

Dogs with a short coat length have a median number of 4 ticks found on the dogs. The median number for dogs with a long coat length is 3.5 ticks. The percentages of dogs having a history with tick fever are 35% for short coated and 33% for long coated dogs (see graph 10).

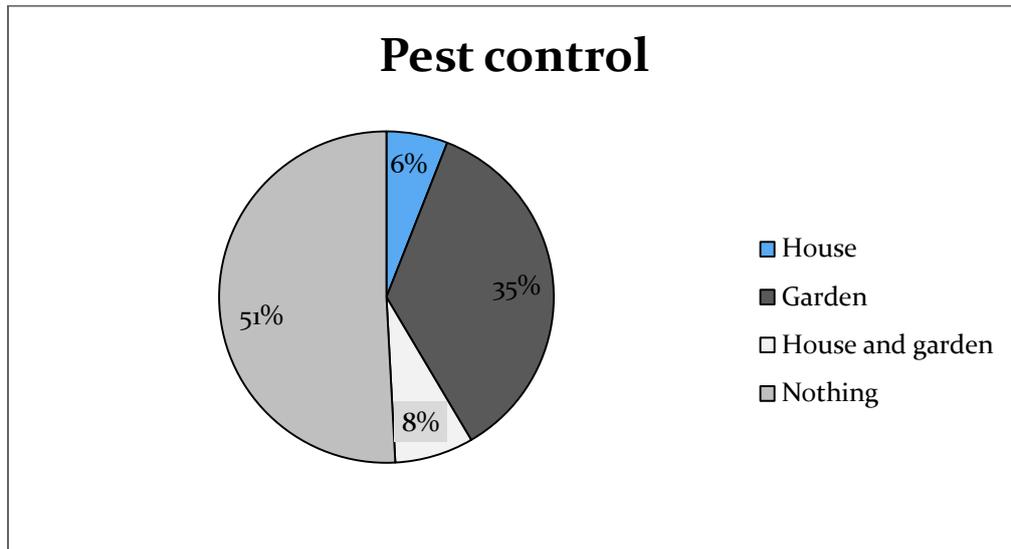


Graph 11: in this graph different coat colors are compared with the median number of ticks found on dogs and with having a history of tick fever. The columns refer to the median number of ticks. The dots refer to the percentage of dogs having a history with tick fever. The median numbers of ticks are calculated by using the numbers of ticks found in one week time by the dog owners. The n numbers displays the number of products per category corrected for dog owners that do not count ticks.

Graph 11 shows the median numbers for ticks found on dogs with a dark colored coat (2), a light colored coat (4) and a spotted coat (6.5). The percentages for dogs with a history of tick fever are respectively 32%, 43% and 28%.

### 3.5 PEST CONTROL

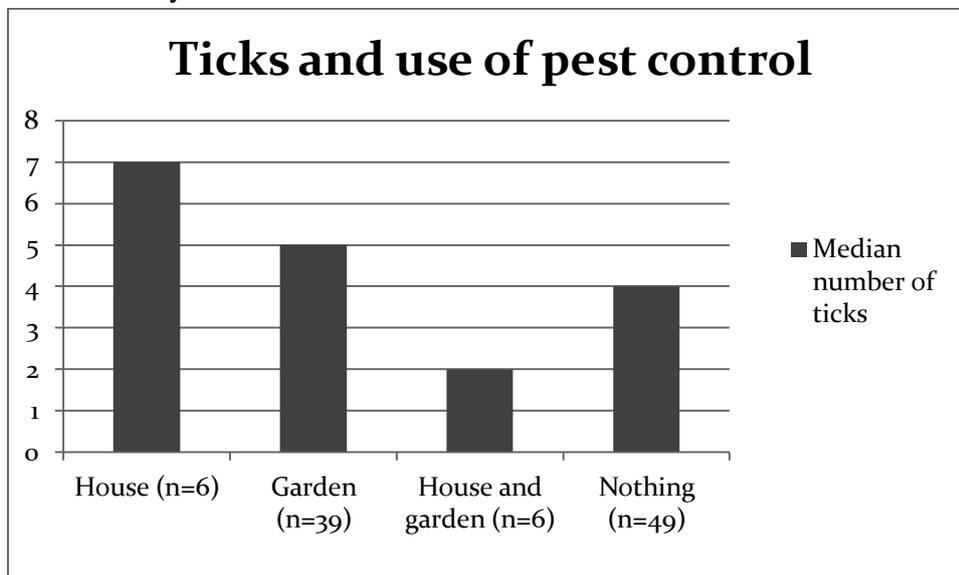
#### 3.5.1 Place of pest control



Graph 12: the percentages are given for owners using pest control at different places.

Graph 12 shows approximately half of the respondents is not using pest control in the environment. People who are using pest control mostly use the products only in the garden (35%). 8% is using pest control only in their houses and 6% is using pest control in the garden as well as in their houses.

#### 3.5.2 Efficacy

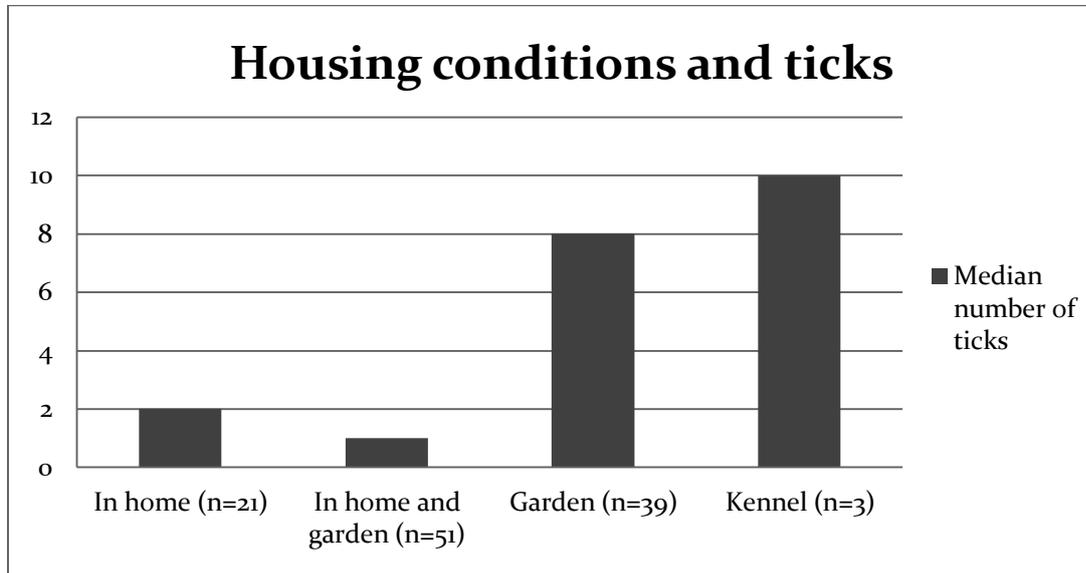


Graph 13: median number of ticks given for different places of pest control. The median numbers of ticks are calculated by using the numbers of ticks found in one week time by the dog owners. The n numbers displays the number of products per category corrected for dog owners that do not count ticks.

The median number of ticks is 7 for only using pest control products in the house, 5 for using pest control in the garden and 2 for pest control in the house and in the garden. Dogs of respondents who use nothing for pest control in the environment have a median of 2 ticks on their dogs (see graph 13).

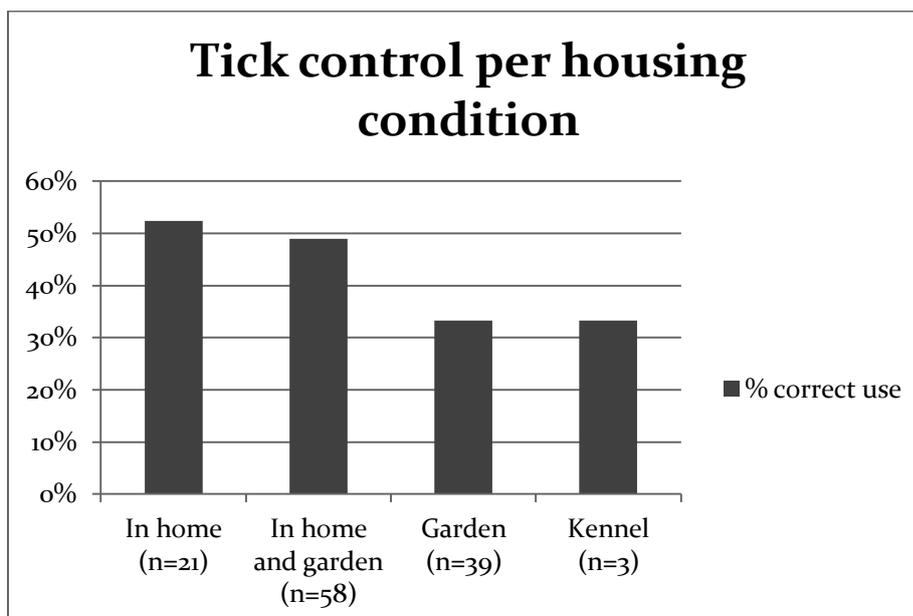
### 3.6 ENVIRONMENTAL INFLUENCES

#### 3.6.1 Housing conditions and ticks



**Graph 14:** median number of ticks given for different types of living places: in home, in home and garden, garden, and housed mainly in a kennel. The median numbers of ticks are calculated by using the numbers of ticks found in one week time by the dog owners. The n numbers displays the number of products per category corrected for dog owners that do not count ticks.

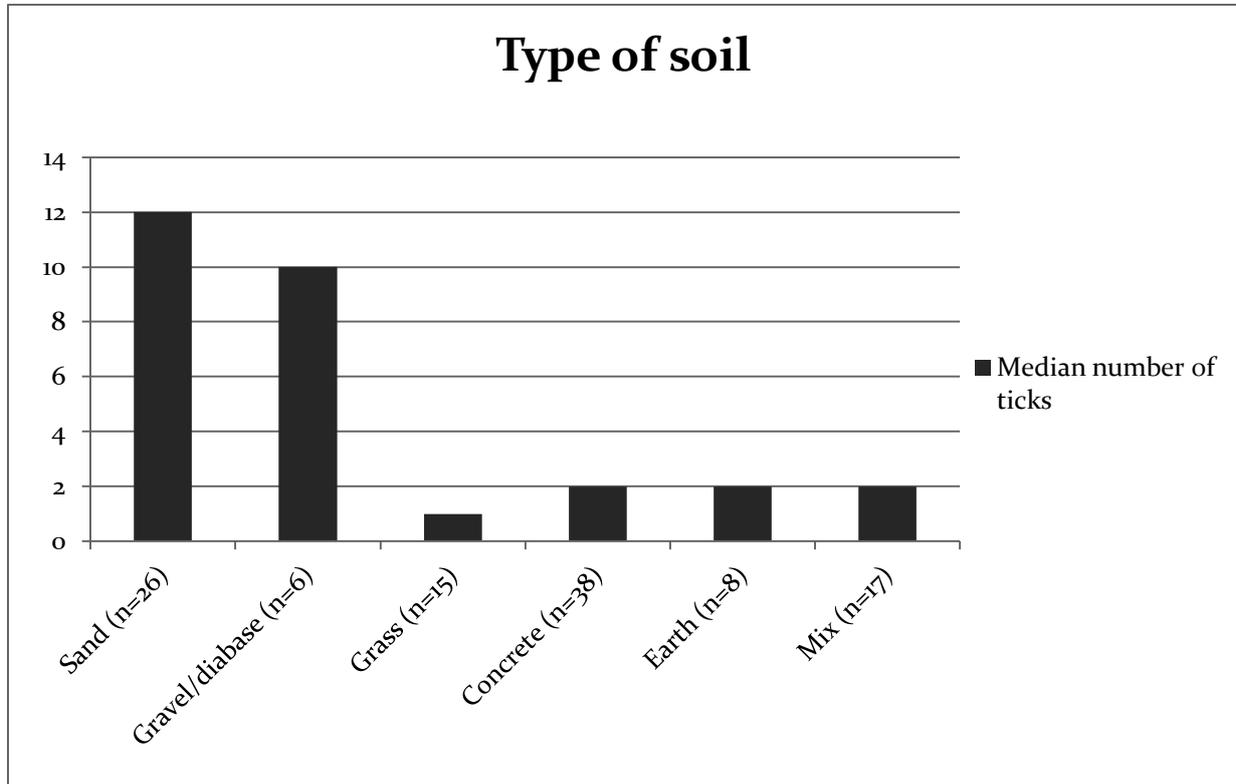
The highest median numbers of ticks are found on dogs living mainly in a kennel followed by dogs living in the garden. Dogs living mainly in home and dogs living in the garden as well have lower median numbers of ticks (see graph 14).



**Graph 15:** percentage of dog owners using tick control products correctly per housing condition. The median numbers of ticks are calculated by using the numbers of ticks found in one week time by the dog owners.

Dogs living in home are more often treated correctly with tick control products compared to dogs in the other housing conditions; in home and garden, in the garden, in a kennel (see graph 15).

### 3.6.2 Type of soil



**Graph 16: median number of ticks on dogs living on different types of soil. The median numbers of ticks are calculated by using the numbers of ticks found in one week time by the dog owners.**

Dogs living outside on sand and gravel/diabase had the highest median number of ticks compared to grass, concrete, earth and combinations of different types of soil (see graph 16).

## 4. Discussion

### 4.1 TEST GROUP

The mean age of the random selected dogs was 3.60. This seems a bit low but is close by and even higher than the mean age of 3.06 found in prior research on Curaçao. (M.M.Klarenbeek, 2010)

This low number might be caused by the frequent visiting of people with pups for the multiple vaccinations needed in the first year. A low life expectancy of dogs on Curaçao might be another possibility.

22 dogs (19%) had a history with tick fever, 21 (18%) had the disease at the moment and one dog (1%) had both a history and the disease at the moment of the interview. In earlier research on Curaçao in 2009 15% had a history and 9% was suffering from the disease. (M.M.Klarenbeek, 2010)

The higher prevalence of the disease may be due to different climatologic influences. The period of the research in 2010 was characterized by more rainfall than usual.

Though 9 dogs is a small group of dogs, all having a history of tick fever by dogs born in non endemic areas suggests that dogs from non endemic areas are more susceptible for this disease. Another contributing factor might be that owners originating from non endemic areas might not be aware of tick fever and thereby consequently be too late with taking tick preventive measures after arriving on Curaçao. If dogs from non endemic areas are indeed more susceptible for tick fever this means dogs in the Netherlands have a higher risk than dogs from Curaçao to get infected by introduction of infected *R. sanguineus* ticks. More research is needed to investigate this topic.

Although tick fever has a high prevalence on Curaçao still 14% of the questioned people was not familiar with tick fever. Compared with one year earlier the situation has only slightly improved. In 2009 13% was not familiar with the disease. (M.M.Klarenbeek, 2010)

Informing clients about tick fever by the first vaccination or by the first consult may be useful.

## 4.2 TICKS AND BLOOD SAMPLES

All ticks found on the dogs belong to the species *Rhipicephalus sanguineus*. This confirms the results of prior research by M.M. Klarenbeek in 2009.

None of the ticks tested with PCR and RLB hybridization were found positive for *Ehrlichia canis*. These results are unexpected, especially because the ticks were collected from dogs diagnosed with Ehrlichiosis by veterinarians.

There are several possible explanations for these unexpected results. One infected tick is capable to transmit ehrlichiosis. By collecting a maximum of ten ticks at the moment of visiting the clinic the pathogen carrying tick(s) might be missed or already fallen off the host. Dogs with ehrlichiosis can also have ticks on them which are not infected, because they recently entered the host and have not been attached and fed long enough to get infected.

Another contributing factor can be that some dogs are possibly misdiagnosed since some dogs were diagnosed with *Babesia vogeli* when tested with RLB. But on the other hand all these ticks were also tested negative for *Babesia spp.* (Luijten, 2011) The presence of another not yet detected type of *Ehrlichia canis* or of another causative agent causing disease with similar clinical signs cannot be ruled out.

Shortcomings in performing the PCR and RLB tests do not seem reasonable because the same techniques were used for testing the blood samples from the dogs leading to multiple positive results for *Ehrlichia canis* and *Babesia vogeli*.

Another explanation for the results might be that the pathogens in the ticks after transporting and storing were not stable enough to be detected by PCR techniques anymore.

The blood samples obtained from dogs diagnosed with ehrlichiosis (n=76) were in 10,5% of the cases positive for *Ehrlichia canis*, 14,5 % for *Babesia vogeli* and in 1% for both pathogens. The presence of *Babesia vogeli* on the Island of Curaçao is hereby confirmed. These results are discussed in the report of Angelique de Mooij. (Mooij, 2012)

## 4.3 TICK CONTROL PRODUCTS

### 4.3.1 Place of buying

A high percentage (92%) of dog owners is using tick control products.

The veterinary clinic is the number one place to buy tick control products (44%) and is followed close by a high number of costumers buying the products at a pet shop (35%). It is uncertain if the salesmen at the pet shops are equally capable to advise costumers in buying tick control products compared to veterinary assistants and veterinarians.

### 4.3.2 Use of tick control products

8% of the questioned dog owners does not use tick control products on their dogs. In prior research on Curaçao this was 19,5% (Klarenbeek, 2010). This difference may be due to more awareness by the questioned people about the importance of prevention of tick fever, because of earlier research done in the clinics. Some respondents had noticed other people were questioned about using tick control products one year ago or they were already questioned themselves.

Because of participating in earlier tick research the veterinarians may have informed more owners about the use of tick control products.

The most popular tick control products are Frontline<sup>®</sup> spot on, Frontline<sup>®</sup> spray, and the Preventic<sup>®</sup> collar used solely and in combination.

It is remarkable that so many users of tick control products (52%) is using more than one product. This makes it more difficult to assess the effect of the tick control products when used solely.

A high percentage of respondents who are not familiar with tick fever (82%) is using tick control products. This suggests the health of the dog isn't the main reason for using tick control products for this group of dog owners. For this group preventing tick fever is an unknown but for the dogs pleasant side-effect.

Owners being familiar with tick fever still have a 11% higher percentage of owners using tick control products compared to users being unfamiliar with this disease. So informing clients about tick fever might be a way to increase the use of tick control products even more.

#### 4.3.3 Correctness of use

Almost half of the used tick control products, 49%, are used incorrectly. The most common used products are no exception: Frontline<sup>®</sup> spot on 50%, Frontline<sup>®</sup> spray 48%, Preventic<sup>®</sup> collar 44%. The main cause is not using the products frequently enough (78%).

Improving the correct use of the products by advising clients when buying may be a way to reach progress in controlling tick fever on the island of Curaçao. Especially the importance of using products frequently enough for prevention of tick fever should be underlined. Using the appearance of ticks on the dogs as criterion to determine the frequency of using the tick control products may lead to dogs with ehrlichiosis.

Since not every owner is checking for ticks daily and detecting one tick while petting the dog can be “the tip of the iceberg”, some ticks will have enough time to transmit *E.canis*.

Out of graph 6 can be concluded that collars (Preventic<sup>®</sup> and others), products to wash the dogs with (shampoos, Paramite<sup>®</sup> Dip) and powders are mostly applied correctly. This may be explained by the ease of use. On the other hand Frontline spot on<sup>®</sup> and Frontline spray<sup>®</sup> are more difficult to use correctly because of the advice not to wash or let the dog swim 2 days before up to and including 2 days after application. Another problem is that some owners do not trust the product to spread over the whole body.

This difficulties might be overcome by giving the owners buying Frontline<sup>®</sup> extra attention in explaining how and when to apply the product and about the way the product spreads over the body (through fat) to get more understanding which will hopefully lead to correct use of the products.

In comparison to the research from M.M. Klarenbeek the correctness of using tick control products has decreased since in earlier research all different products were correctly used by at least 50% of the dog owners. (Klarenbeek, 2010)

Another outcome by another manner of questioning is possible. Considering correctness of use is especially an item where answers can be influenced by respondents not willing to give honest answers a lower percentage of correctness seems more rational than a higher outcome.

#### 4.3.4 Efficacy

In this study the median number of ticks are used instead of the mean number of ticks. This way the results will be less influenced by the presence of extreme values that are not uncommon when counting ticks on dogs.

The median number of ticks on the dogs in this study is determined by asking the dog owners for the average number of ticks they usually find in a week. This method can negatively affect accuracy since the respondents differ in the effort made for looking for ticks on their dogs and they might not always be completely honest when answering the questions.

Another method is to count ticks on the moment of visiting the clinic. This method is also not utterly accurate given that this results are based on a snap shot of the situation. The number of ticks on a dog can vary each day since this is influenced by a lot of variables like the weather, last visited places, moment of last used tick control product and housing conditions.

It is a pity that about half of the users of tick control products is not using the products frequently enough or with a faulty manner of application. This makes the results for efficacy of the products less accurate since a small test group per product remains after correcting for incorrect use. This is especially true for the products that are used less often like the use of other collars (n=2), powders (n=3) and paramite (n=4).

Since a lot of respondents use more than one tick control product on a dog it should be kept in mind that low median numbers can also be caused by another used product or by a synergistic effect. Especially the high efficacy of powder is questionable as all powders used by the respondents were used in combination with another tick control product and next to this the amount of correct used paramite products is small.

The high median number on dogs treated with Ivomectin<sup>®</sup> injections is probably found due to the use when dogs are heavily infested with ticks instead of using the product in a preventive manner.

In the research by on Curaçao by M.M. Klarenbeek the most effective products seemed to be shampoo, Preventic<sup>®</sup> collar, Frontline<sup>®</sup> drops and spray (Ovitrol<sup>®</sup> efficacy was not measured). (Klarenbeek, 2010)

This resembles the outcome of this research except for the lower found effectiveness of shampoo and higher effectiveness of powder.

The different brands of shampoo, which are not differentiated in this research, might have variable efficacy leading to a non reliable result.

The accuracy for the powder result is low due to use of the product only in combination with others and due to a low test group as mentioned earlier in this paper.

The least effective product was Paramite<sup>®</sup>. Although this outcome is not very reliable due to the small number of correct users, this resembles the result found by M.M. Klarenbeek who also found Paramite<sup>®</sup> as the least effective product. (Klarenbeek, 2010)

Out of graph 7 can be concluded that the use of tick control products on dogs is beneficial regarding the low number of ticks on the dogs treated with tick control products compared with untreated dogs. Incorrect use of the products seems to decrease efficacy although the decline of efficacy is not tremendous. This may indicate some products will work under the instantaneous conditions on Curaçao despite of being applied faulty and some products may work longer than following the manufacturers instruction when given less frequently.

The median numbers of ticks do not correspond with the percentages for satisfaction. This equals the results from M.M. Klarenbeek. (Klarenbeek, 2010)

The products in the category “Remaining” have the highest satisfaction rate despite of containing many products that are not scientifically proved to be efficient or even lack theoretical possibilities to work against ticks. Also the median tick numbers on dogs are almost equal to the numbers of ticks found on dogs not treated with tick control products.

The opinion of owners from dogs seems to be incapable to determine efficacy of tick control products. This may be due to differences in expectations about the efficacy of the products and also non efficacy related factors like the costs and the effort needed for correct application.

Since Frontline<sup>®</sup> spot-on, Frontline<sup>®</sup> Spray and Preventic<sup>®</sup> collar are the most used products on Curaçao the literature about these products will be discussed in the following subsections.

### Frontline

The active ingredient of Frontline<sup>®</sup> Top Spot and Frontline<sup>®</sup> Spray is fipronil. Fipronil is a non-competitive GABA (gamma-amino-butyric acid) inhibitor. It interferes with the central nervous system through disturbance of the GABA regulated chloride channels leading to uncontrolled central nervous system activity which results in death of invertebrate animals. Fipronil binds less tight on GABA receptors of vertebrates. (Tingle *et al.*, 2000)

In a study in 2010 six dogs were treated with Frontline<sup>®</sup> spot on after experimental infestation with unfed adult *Ixodes ricinus* ticks. Ticks were applied on day -7, -2, 7, 14, 21, 28 and 35. Day 0 is the day of treatment as will be in all the following described studies. Ticks were counted 48 hours after every challenge. The mean geometric efficacy was 100% on day 23 and 86,3% on day 30. In conclusion the dogs were protected from re-infestation with an efficacy of >90% for three weeks. (Bonneau *et al.*, 2010)

In another research sponsored by Merial the efficacy of Frontline<sup>®</sup> Top Spot was tested after application of fifty *R. sanguineus* ticks on day -2, 13, then weekly. The efficacy was 91,5% on day 2 and 98.1% on day 29. (Kidd & Breitschwerdt, 2003)

In a study by Rugg and Hair in 2007 50 *R. sanguineus* ticks were applied on day -2, 5, 12, 19, 26, 33 and 40. Counting of ticks two days after application led to a 100% efficacy (and geometric mean of 0 ticks) from counting day 7 to 28, followed by an reducing efficacy of 99,5% and 89,2% on respectively day 35 and day 42.

Davoust *et al.* set up a one year during trial in endemic areas in Afrika to evaluate the efficacy of fipronil spot-on (Frontline<sup>®</sup> spot on) to prevent *E. canis* transmission by *R. sanguineus*. Dogs were checked for tick infestation, clinical status and *Ehrlichia* seroprevalence. Monthly with Frontline Spot-on treated dogs didn't develop clinical symptoms of ehrlichiosis. Seroconversion in untreated control groups ranged from 21,7% (dogs living with citizens) to 100% (dogs housed in kennels) while treated dogs had a seroprevalence ranging from 2,7% to 5,5% (both housed in kennels). (Davoust *et al.*, 2003)

This study is valuable, because not only the number of ticks is evaluated but also the seroprevalence of *Ehrlichia canis* and ehrlichiosis in dogs.

Unfortunately there is not much data available about the in vivo efficacy of the fipronil formula as Frontline Spray.

Another spot-on formula from Frontline<sup>®</sup> is Frontline<sup>®</sup> Plus, which is a combination of fipronil 10% and (S)-methoprene 9%, an insect growth regulator (Brianti *et al.*, 2010).

In a prior study with experimental infested dogs checked for ticks 2 hours after infestation on day -3, 3, 7, 14, 21, 28 and 35 efficacy percentages for Frontline<sup>®</sup> Plus varied between -28,1% and 56,8%. (Young *et al.*, 2003)

This agrees with the statement that fipronil starts to kill ticks 12 hours after application and peak of lethality is reached after 24 hours. (Davoust *et al.* 2003)

The maximum efficacy is achieved after ticks have the opportunity to attach and feed (Young *et al.*, 2003)

This also explains why some respondents complain about Frontline<sup>®</sup> since they are still finding living ticks on the dog after application.

In another study in which ticks were infested on day 2, 9, 16, 24 and 30 and counted 24 hours after infestation percent efficacy was respectively 100%, 96%, 88,5%, 88,2% and 69,3% for Frontline<sup>®</sup> Plus. (Kidd & Breitschwerdt, 2003)

Based on the last two described studies still cannot be concluded that Frontline<sup>®</sup> Plus is less effective than Frontline<sup>®</sup> Top Spot because in these studies ticks were counted within one day after tick infestation.

In a field trial with Frontline<sup>®</sup> Plus under natural conditions by Brianti *et al.* ticks were counted on day 0, 2, 7, 14, 21 and 28. The overall efficacy (adults and immature stage) was 96,1% in the first week, 96,6% in the second week, 94, 2% in the third week and 93,4% in the fourth week. Tick counts did not significantly differ from completely soaked through dogs on day 14 after application of the spot-on formula.

### Preventic

Amitraz is a formamidine pesticide. It kills insects by acting on the neuromodulator octopamine. (Chen *et al.*, 2007)

Through the paralyzing effect on the central nerve system and thereby interfering with the function of the mouthparts ticks are prevented from biting. (Estrada-Pena & Reme, 2005)

In a study from Estrada-Pena and Ascher dogs were infested naturally by a two hour walk on day -3 then weekly from day 7 to day 70. Percentages of dogs totally free of ticks (n=10) was 100% on day 2 and day 3, 90% on day 14, 70% on day 21, 90% on day 28 and 80% on day 35. (Estrada-Pena & Ascher, 1999)

In a study in 2005 from Estrada-Pena and Reme dogs were infested with adult unfed ticks belonging to different tick species; *R. sanguineus*, *I. scapularis*, *I. ricinus*, on day 8, 10, 13 and 18. Feeding female ticks were counted on day 10, 13, 18 and 28. The investigators counted respectively 1, 2, 1 and 1 female feeding tick on the dogs challenged with *R. sanguineus*.

### New developments

Nowadays new tick control product are being developed containing combinations of various acaricides like CERTIFECT<sup>™</sup> ( a combination of fipronil, amitraz and (S)-methoprene and ProMeris ( containing Metaflumizon and Amitraz)). (Rugg & Hair, 2007; Hunter *et al.*, 2011)

Using combinations can lead to higher efficiency of tick control products. For example, in vitro a higher mortality of *R. sanguineus* was reached by using fipronil in combination with amitraz compared with using fipronil alone. The combination also provided a significant improvement in the speed of kill. (Prullage *et al.*, 2011)

Using amitraz in combination with pyriproxifen made the surviving females unable to oviposit. (Estrada-Pena & Reme, 2005)

This may contribute to lower tick counts in the environment next to efficient tick control on the dogs. In the future after further research oral ascarides like Spinosad may be suitable for use as efficient tick control products. (Snyder *et al.* 2005)

#### 4.4 INFLUENCE OF INDIVIDUAL CHARACTERISTICS

No significant difference is found between the mean number of ticks on crossbred dogs and pure-bred dogs. In some studies differences have been found between various pure-bred dogs. In research by Louly *et al.* English cocker spaniels seemed to be more susceptible to *R. sanguineus* than Beagles. Equal experimental tick infestation of both dog breeds led to a higher amount of all stages of the tick and eggs on the English cocker spaniels. (Louly *et al.* 2009)

In further research it was indicated that this tick has the ability to distinguish between sensitive and resistant dogs before acquiring a host. (Louly *et al.* 2010) Further research is needed to discover the underlying mechanisms on which this ability is based on.

In an earlier study higher proportions of ticks were counted on long-haired dogs than on short haired dogs. (Jacobs *et al.* 2001)

This seems reasonable because ticks may be able to enter hosts with long coats easier because of having more surface to attach to.

Nevertheless in this study shorthaired dogs and longhaired dogs do not differ much in median tick numbers and history of tick fever.

No studies have been found comparing Ehrlichiosis prevalence with different coat types of dogs.

In graph 11 it is remarkable that the median numbers of ticks do not correlate with the percentages of dogs with a history of tick fever.

Spotted dogs had the highest median number of ticks while the highest percentage of having a history with tick fever is found by dogs with a light coat color.

This might be caused by more use of tick control products on dogs diagnosed with tick fever in the past. Or other factors than susceptibility of the dogs determined by coat color having more influence in non experimentally controlled situations.

Dark coated dogs had the lowest median number of ticks in this study. Ticks might be harder to detect on dark coated dogs but with this theory the most ticks should be found on dogs with a light coat color while the most ticks were found on dogs with a spotted coat.

No other studies have been found comparing coat color with tick numbers.

#### 4.5 PEST CONTROL

Since *R. sanguineus* is a threehost tick this specie lives most of its lifetime in the environment instead of on the host.

In optimal environmental conditions *R. sanguineus* is capable to survive for 19 months in the environment. (Dantas-Torres, 2008)

This explains why pest control measures could work in tick prevention. Despite this fact only half of the respondents is using products for pest control in the environment.

Since *R. sanguineus* can live indoors and outdoors as well pest control in the house and the garden is expected to have the highest efficiency in preventing ticks. Median tick counts on dogs of owners using products for pest control in home and in the garden are in this study indeed lower compared with dogs of owners only using pest control products in one of both places.

But the median tick numbers on dogs of owners using pest control products only in the garden or only in home were even higher compared with dogs belonging to respondents that don't use pest control products.

Finding higher median numbers of ticks on dogs from dog owners who take pest control measures might be explained by starting with the use of pest control products because already having huge tick infestation in the environment.

Assuming this the results of this research suggest using pest control products only in the garden may be more effective than only in the house.

Unfortunately there are a lot of reasons to assume the results are not very reliable. At first the groups of respondents counting ticks on their dogs and using tick control products only in home and both in home and in the garden are small.

Another factor having influence on the reliability is the minimal knowledge about pest control. A lot of respondents are using products for pest control while they often do not know if these products are working against ticks. Many questioned dog owners couldn't mention what products they exactly use for pest control and dog owners naming products intended to use for normal house cleaning but not containing any pesticides was no exception.

Especially for people taking pest control *measures* in the garden this was mainly done by pest control companies. Some respondents specifically mention to these companies that they wanted to get rid of ticks next to other insects (mainly cockroaches) while others mention nothing and assume all products used by these companies are effective against ticks.

Further research is needed to get more reliable results about the efficacy of tick control products in the environment. In such research more attention is needed for the specific products that are used in house and garden, in which manner and how often. It is also important to include information about how often dogs come outside the with pest control products protected environments. Especially counting ticks in houses and in the gardens could give valuable information about the effectiveness of pest control products because with this method possible higher susceptibility of dogs for ticks for example caused by breed, coat length or coat color will not influence the test results. It is also interesting to investigate if the use of pest control products in gardens is useful when the neighbors are not.

## 4.6 ENVIRONMENTAL INFLUENCES

### 4.6.1 Housing conditions and ticks

When comparing the living places of dogs the highest median number of ticks was found on dogs living mainly in a kennel. This result is questionable because only three dogs of which the owners were counting ticks were living mainly in a kennel. Despite the low reliability this result equals the result from research by Davoust *et al.* where dogs in kennels were infested with ticks more often than dogs living in houses and surrounding gardens. (Davoust *et al.*, 2003)

Dogs in a kennel are living on a small surface, making it easy for *R. sanguineus* to (re)enter a host after falling off between the different stages of development.

In research in Japan dogs with access to a garden had significantly more *R. sanguineus* ticks. (Shimada *et al.* 2003)

In this study in Curaçao dogs only living in the garden had indeed more ticks compared with dogs only living in home. But dogs living in home with access to the garden appear to have the lowest median number of ticks.

A greater surface to live on might contribute to this low median tick number in combination with probably more often cleaned resting places inside the house.

The lower median numbers of ticks found on dogs living in home or in home and the garden may next to the housing condition itself be achieved by the higher percentage of dog owners using tick control products correctly compared with dog owners having their dogs housed outside (mainly in the garden or in a kennel).

Possibly these owners are more motivated to treat their dogs with correctly applied tick control products and used frequently enough because they might detect ticks earlier when the dog lives in home or they do not like having a dog infested with ticks inside their houses but do care less when the dog lives outside.

### 4.6.2 Type of soil

In earlier research in Curaçao the highest numbers of ticks were also found on dogs with access to a garden consisting of sand. (M.M. Klarenbeek, 2010)

Sand might give the opportunity for the tick to hide by burying itself or to live in a more suitable humidity.

*R. sanguineus* ticks, especially engorged females, can be found hiding in cracks of walls and between stones. (Dantas-Torres *et al.* 2010)

Since gravel and diabase are also able to provide enough space for hiding, finding a high median number of ticks on these types of soil seems reasonable.

Adapting the garden by decreasing the amount of sand and gravel/diabase might be a simple and compared to the use of pesticides environmentally friendly manner to prevent tick infestations of the dog.

## 5. Conclusions

The accuracy of the results from this study can be influenced by the size of the test group especially for calculating the efficacy of tick control products, because the group of owners using tick control products correctly was lower than previously expected because about half of the respondents does not use the tick control products correctly and not all respondents are used to remove ticks on their dogs. In addition it is not certain if all respondents have answered the questions entirely fair and correct and each outcome might be influenced by a lot of present variables.

Consequently this study could not lead to precise statistical significant outcomes.

Nevertheless this study in combination with the results from M.M. Klarenbeek in 2009 reveals more topics that are interesting for further research and gives a rough overview of the situation in dogs that visit veterinary clinics on Curaçao and gives the opportunity to improve education for the local dog owners.

Further research is needed to gain more knowledge about the effectiveness of the most used tick control products with less variables and under similar circumstances to be able to compare them. Care should be taken to use the tick control products administered correctly and frequently enough applied.

Studies comparing the efficacy of tick control products on dogs are scarce. Especially those comparing more than two products. Most studies compare only two products and are difficult to compare with other studies since the methods and experimental conditions altered.

Some results are in geometric means, others in means and the method of tick counting can also differ. For instance some count only adult fed females while others count all stages and some only differentiate between dogs having ticks and dogs not having ticks. Next to this some studies vary in the use of tick species and the moments of tick infestation and tick counting.

Since tick fever is a common life-threatening disease in dogs on Curaçao, taking tick control measures to prevent tick infestation on dogs is important. Especially now next to *Ehrlichia canis* spp. another by ticks transmissible pathogen, *Babesia vogeli*, is found in the blood samples from dogs on the island.

Tick control products can contribute to lower tick counts on dogs. According to this study the efficacy varies per used tick control product. On the island of Curaçao more education about tick fever and particularly about the use of tick control products might be a way to help in preventing this disease in dogs because almost half of the products is not used following the instructions given by the manufacturers.

Fortunately incorrect used tick control products still seem to decrease tick numbers on dogs when the tick numbers are compared with untreated dogs. But given that one tick bite is enough to be able to transmit *Ehrlichia canis* and *Babesia vogeli* local education about tick control products might be able to increase the correctness of use and thereby the prevalence of tick fever on the island.

Since *Babesia vogeli* is found in blood samples obtained from dogs with clinical symptoms of tick fever, and with babesiosis infected dogs are usually treated with imidocarb dipropionate instead of with doxycycline, veterinarians should be made aware of the presence of *Babesia vogeli* on the island of Curaçao to earlier recognize and treat Babesiosis effectively.

This study combined with literature about *R. sanguineus* leads to the following list of recommendations for dog owners on Curaçao.

#### *List of recommendations*

- Use tick control products **to prevent** tick infestation following the recommended frequency given by the manufacturers. It is better not to wait until the dog has a lot of ticks in order to determine the frequency of applying the tick control products, because only one infected tick is capable to transmit pathogens causing tick fever.
- When using Frontline:
  - The correct place to apply the spot on formula is on the skin between the shoulder blades.
  - Do not wash the dog or let the dog swim 2 days before up to and including 2 days after application of the product.
  - Do not worry when ticks do not fall off immediately. The first ticks will be killed after the first 12 hours. Peak mortality is reached after approximately one or two days.
- Additional measures that could help:
  - Increase of living space: do not house the dog mainly in a kennel.
  - When your dog lives outside try to avoid your dog to live mainly on sand and gravel or diabase.
  - Pest control measures in the environment.
    - Ideally when dogs live in home and in the garden use pest control products at both places.
    - When using pest control products to get rid of ticks check the labels on the products to see if it's working against ticks.
    - When you let a pest control company take care for your garden and/or house do not forget to mention that you also want to get rid of ticks.
- When a dog shows signs of tick fever always visit a veterinarian because waiting too long can lead to a chronic form of this disease that is more often not well responding to therapy.
- Even visit a veterinarian when the dog shows signs of tick fever when you have never seen or found ticks on the dog. Because the tick responsible for transmitting tick fever might already have fallen off the dog.

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## Appendix I - Questionnaire

### Questionnaire dog owner

Name veterinary clinic: \_\_\_\_\_  
Date: \_\_\_\_\_  
Name: \_\_\_\_\_  
Name of the dog: \_\_\_\_\_  
Sex: male/female  
Age : \_\_\_\_\_  
Breed: \_\_\_\_\_  
Coatlength: Long / Intermediate / Short  
Coatcolor: Dark/ Light / Spotted  
Reason of consult: \_\_\_\_\_

Are you familiar with 'karpattenziekte'? Yes / No

Has the dog had tick fever? Yes/No

Are you familiar with Babesiosis? Yes/No

Do you have more dogs and how many?

Did these dogs ever had tick fever?

Do you use tick control products on the dog? Yes/No?

Where do you buy tick control products?

At the veterinary clinic  In a petshop or supermarket

Welk middel?:

Frontline spot on  Preventic collar  Powder

Frontline spray  Ovitrol plus spray  Shampoo

Paramite  Ivomec injection  Other: \_\_\_\_\_

Sergeants collar

How frequent do you use the product(s)?: \_\_\_\_\_

How do you apply the product(s)?: \_\_\_\_\_

Are you satisfied with the products?: Yes/No?

When answered with no, why are you not satisfied?

Do you check your dog on having ticks? Yes/No?

How frequently?

How many ticks do you find when checking the dog? \_\_\_\_\_

Do you use pest control for ticks in the environment Yes/No?

Do you use the product(s) in the garden, in the house or both? \_\_\_\_\_

What product(s) do you use? \_\_\_\_\_

Where does your dog live and sleep? mainly in the house/ mainly outside/ in the house and outside

When the dog lives mainly outside: what are his living conditions

In a kennel/ On a chain/ loose

What type of soil has your garden

Sand/Gravel/Grass/Concrete

Is your dog ever been abroad? So yes in what country?

**Thank you for filling in this questionnaire!**

## Appendix II – manufacturers information

Products active ingredients and effective period against ticks following the manuals from the manufacturers

Product	Active ingrediënt	Effective period against ticks
Frontline <sup>®</sup> spot on	fipronil 9,7%	4 weeks
Frontline <sup>®</sup> spray	fipronil 0,29%	4 weeks
Preventic <sup>®</sup> collar	amitraz 9%	90 days
Vet Kem <sup>®</sup> Ovitrol Plus Flea, Tick and Bot Spray	methoprene 0,27% pyrethrins 0,20% piperonyl butoxide 0,37% n-octyl bicycloheptene dicarboximide 0,62%	2 months
Ivomectin <sup>®</sup> 200 ml 1% sterile solution	Ivermectine	No information for dogs, only registered for cattle
Wellmark <sup>®</sup> Paramite Dip	phosmet 11,75%	16 days against the Brown dog tick