The Efficacy of Natural Repellents in Ticks

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Abstract

Ticks carry diseases and can be harmful to animals and humans. The *Amblyonna americanum* species, or the Lone Star tick, is a commonly found tick in the United States and is a particularly aggressive species. There are many products used to repel ticks and other insects, but consumers are starting to want natural products instead of traditional synthetic ones. There is not much consensus as to what natural product or essential oil works best. This study looked at three natural repellents, Ultrashield Green, Outsmart, and Pyranha Zero-Bite, to determine which one would repel ticks the best. Ultrashield Green was the only product which was effective at repelling ticks compared to the control.

Keywords: Repellent, natural, Lone Star tick, *Amblyonna americanum*

Introduction

Ticks and tick borne diseases affect thousands of people every year. Ticks carry many diseases with them like bovine anaplasmosis, Lyme disease, Rocky Mountain spotted fever and babesiosis and can affect livestock, wildlife, companion animals, and humans. The CDC states there are up to 300,000 cases of Lyme disease each year, not to mention any of the other tick borne diseases (CDC Newsroom). Many tick species like *I. scapularis*, *D. variabilis*, and *A. americanum* are commonly found in North America and do transmit diseases. However, the Lone Star tick, *Amblyonna americanum*, has been found to carry Lyme disease in high numbers throughout the US (Springer et al., 2014). The Lone Star tick is known as an aggressive species compared to the others, and can affect humans and animals in many stages of life. In the Southern and Eastern US it is the most commonly found tick (Meng et al., 2015).

A common repellent against ticks is N, N-diethyl-meta-toluamide, or DEET. DEET is a synthetic repellent found in many products. However, there is some concern from the public if synthetic products like DEET are toxic to their health and the health of their animals (Machtinger et al., 2017). However, studies have found that DEET is generally safe for use with few people experiencing side effects (Osimitz and Grothaus 1995; Qiu et al., 1998). The reported side effects that did occur were toxic encephalopathy, seizure, acute manic psychosis, cardiovascular toxicity, and dermatitis (Qiu et al., 1998). A few cases of death were reported due to excessive skin absorption of DEET. Instead of these synthetic products many people have turned to natural ones which have essential oils like peppermint, clove, or geranium (Machtinger et al., 2017; Meng et al., 2015), or they use the essential oil by itself. In general, products which are natural or involve botanical elements have been increasing in popularity dramatically. Many consumers worldwide prefer products (of any kind) that are natural in some way. However, there is not much consensus among consumers or scientists as to which essential oil or which natural product is the best, and that is very much true for insect repellents. Whether or not these oils repel ticks well is not as widely studied as synthetic repellents such as DEET. As tick disease can be a

serious health issue, it is important that the efficacy of these products be tested. The purpose of this study was to determine which product, if any, repelled ticks better than the others.

Materials and Methods

Ticks

The Lone Star ticks used in this study were acquired from a colony from the OSU National Tick Rearing Facility. Before being used, they were maintained at 62-69 ˚F, 30-70% relative humidity, in a 15 hour light/9 hour dark light cycle, and were raised pathogen free. Lone Star ticks were used because they are particularly aggressive and are more willing to climb. Climbing propensity was preferred for this study because a vertical filter bioassay was used to determine repellency. Tick species which are not as active as the Lone Star tick would not have provided accurate data for repellency. Ticks used for this study were unfed which makes their behavior more active as they were meal seeking.

Products

Three products were used in this study with tap water as the control. They were chosen because they were commonly used products that could be found in many stores. The products were Ultrashield Green Fly Repellent, Outsmart Fly Spray, and Pyranha Zero-Bite. Ingredients for each product are listed in Table 1. Ultrashield Green claims to repel biting flies, mosquitos, and gnats on horses, ponies, foals, and dogs for up to eight ours. Its instructions are to spray directly on coat after brushing fully, avoiding any mucous membranes and the eyes. Use a cloth to rub the spray around the eyes and face. Outsmart Fly Spray claims to repel flies, mosquitos, and ticks for horses and riders, and is non-toxic when used as directed. They recommend testing their product on a small patch of skin before use on horse and rider if both are going to use it. Directions for use on horses are to brush the coat thoroughly to remove dirt. Hold the nozzle eight inches from the horse’s coat and spray evenly with a light mist, and use a cloth with the spray to apply on the face and other sensitive areas. It states do not spray on or near face, eyes, ears, or mucous membranes. For riders, it says to evenly spray skin with light mist and then spread with hands to moisten skin. It states do not spray directly on or near face. Pyranha Zero-Bite states they are a natural insect repellent for use on horses, dogs, cats, ferrets, caged pets, and their premises. It claims to kill and repel stable flies, deer flies, fleas, house flies, horse flies, ticks, face flies, horn flies, lice, mosquitos, bot flies, and gnats. Two ways of application are given for horses and ponies: wipe on use and spray use. For wipe on use, they recommend brushing thoroughly to remove dirt and to lightly moisten a cloth to rub over hair in opposite direction of hair growth. For spray use, lightly spray over coat and then brush the coat. For other pets, the instructions for application are to start spraying at the tail, moving the dispenser rapidly and making sure the animal’s entire body is covered. While spraying, fluff the hair so that spray will penetrate to the skin. Make sure it wets thoroughly, but do not saturate the animal. For all uses, do not spray around the face, eyes, or mucous membranes.

Ultrashield Green	**Outsmart Fly Spray**	**Pyranha Zero-Bite**
Sodium Lauryl Sulfate 2.5%	Geraniol 2%	Geraniol 1.0%
Geraniol .7%	Water	Clove Oil .5%
Clove Oil .08%	Isopropyl Alcohol	Peppermint Oil .25%
Citronella Oil .06%	Peppermint Oil	Sodium Lauryl Sulfate 3.84%
Rosemary Oil .05%	Soap	Water
Lemongrass Oil .05%	Glycerin	Glycerin
Cedar Oil .05%	Potassium Sorbate	
Thyme Oil .01%		
Water		
Glycerin		

Table 1. Ingredients for each product are listed in the order they are listed on their label.

Repellency Bioassay

Ticks which are seeking a host are more willing to climb up, so a vertical filter bioassay was used (see Figure 1) (Meng et al., Essential Oil as Repellents against Ticks). Whatman grade 4 filter paper was cut into 4 x 7 cm strips of paper. These strips were marked into two 1 x 4 cm at the ends with a 5 x 4 cm central area. 165 uL of each solution was put onto the center areas of different strips. Another strip had 165 uL of water and was used as the control. These strips were dried for fifteen minutes before the trials began. They were then hung from a dowel rod from bulldog clips over an arena. The arena was a setup of two petri dishes. A 60 mm petri dish was glued to the inside of a 90 mm petri dish so a moat with water could be created to prevent ticks from climbing out of the arena. The bottom of each strip of filter paper touched the center of the petri dish. For each trial, a new petri dish was used for every arena so that leftover residue from a past trial would not affect tick behavior.

Ten *A. americanum* ticks were then placed into the arena, five of which were male and female. The locations of the ticks were recorded at three minute intervals for 30 minutes. Locations of male and females were recorded separately. Their location could be designated as: 1. past the treated portion, 2. on the treated portion, 3. on the bottom untreated portion, 4. in the arena, or 5. in the water. Ticks were considered in the water if they were fully immersed. Ticks can live in water for up to and even past 24 hours. Their typical behavior, however, does not include immersing themselves in water. Otherwise they were considered in the arena. Ticks which were considered repelled were those that immersed themselves in water during the trial. If they remained in the arena, climbed onto the filter paper, or climbed past the treated portion they were considered not repelled. Ticks which climbed out past the moat were put back into the arena. New ticks were used for every trial.

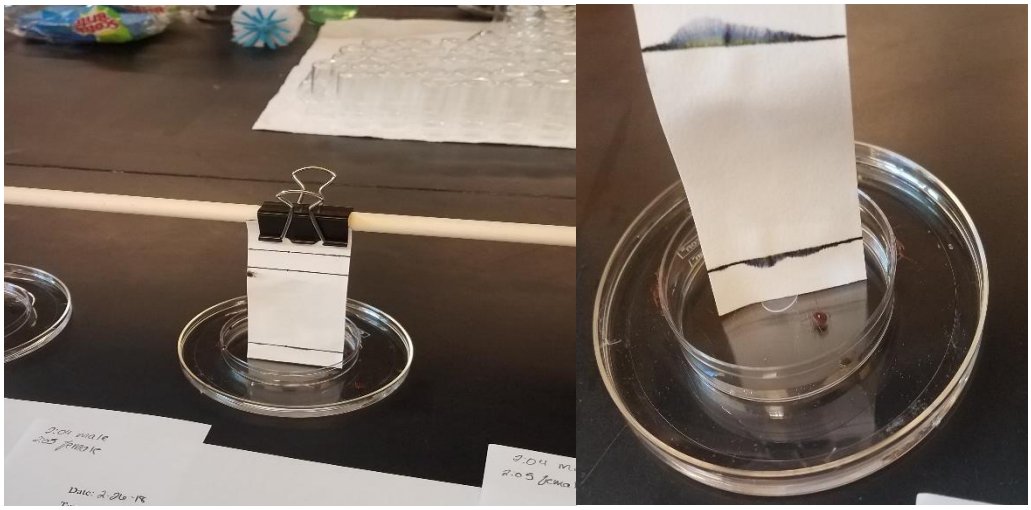

Figure 1. Pictured is the vertical filter bioassay used in the trials.

Data Analysis

The SAS 9.4 software program was used for data analysis and results. Repellency was analyzed by PROC GLM and separated with an LSMeans test at 95% confidence. The average probability of repellency was determined from these tests.

Results

The probability of repelled ticks is shown in Figure 2. The average probability of repellency was compared for the four variables. The control was a baseline for normal tick behavior. Ultrashield Green had the highest probability for repelling the ticks (.4375) and was significantly higher than the other treatments and the control (P= <.0001, F= 8.54, dF= 3,156). Outsmart (.2575) and Pyranha Zero-Bite (.23) were not significantly different from each other, and were not as effective as Ultrashield Green. Outsmart and Pyranha did not differ significantly from the control (.175). They were as effective as the control at repelling ticks. The value reported for the control does not indicate the ticks were repelled, but rather the normal behavior of the ticks throughout the trials. Outsmart and Pyranha Zero-Bite did differ from the control, or the normal behavior, but not significantly enough to indicate repellency. Values reported indicate average probability of repellency and can also be read as percentages. For example, 43.75% of ticks were repelled from Ultrashield Green. Figure 2 indicates these results with letters A and B. Letters which are the same are not significantly different. Letters which are different are significantly different. Barometric pressures for trial 1, 2, 3, and 4 were 30.16 in. Hg, 29.73 in. Hg, 29.91 in. Hg, and 30.27 in. Hg, respectively. Temperatures for each trial were 75 ˚F, 74.1 ˚F, 75 ˚F, and 73.9 ˚F, respectively. Standard error generated from SAS 9.4 was .0389.

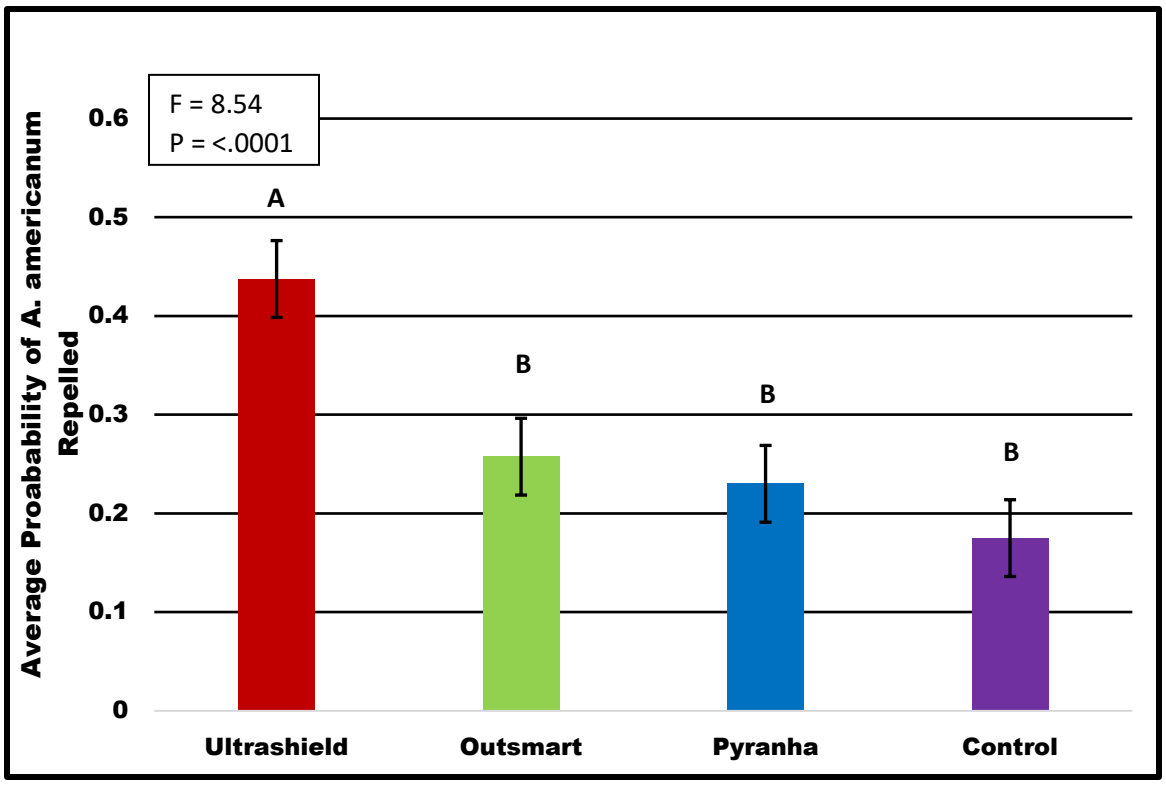

Figure 2. Repellency means with the same letter are not significantly different. Ultrashield Green was the only product which differed significantly from others.

Discussion

This study compared the repellency efficacy of three common products to each other and to a control which was tap water. Only one product, Ultrashield Green, was able to repel the ticks well. In comparison to the others, it was the only one that could repel the ticks. When ticks were placed into the arena with Ultrashield Green their behavior was erratic and they would almost all immerse themselves in water to seemingly get away from the filter paper. This fleeing behavior was not observed with the other products or control. However, this behavior was not as intense as the trials went on. Ticks still were observed as fleeing from Ultrashield Green, but at less intense levels. Since different ticks were used for each trial, why the behavior was less erratic for the later trials compared to the first is unknown. Out of three ticks which actually escaped the moat during the trials, they were all from the arena of Ultrashield Green. These ticks were placed back into the arena to continue observations. However, they should have been considered repelled. Their behavior was still indicating they were being repelled as they were trying to get away from the arena. The repellency value for Ultrashield Green should therefore be higher Ticks did go into the water for the other products, but since they were not significantly different from the control, the tick behavior is credited as normal tick behavior and not repelled behavior. For the control, 17.5% of ticks went into the water naturally. Outsmart and Pyranha Zero-Bite had 25.75% and 23%, respectively, go into the water. This indicates very little repellency as most of them would go into the water anyways. While temperature and barometric pressure are known to affect ticks, they did not vary enough to cause significant changes in behavior over the course of the trials.

Essential oils are the majority of the ingredients for these products. These oils are part of the booming popularity of natural products and are used for many things. Many studies have researched the repellency of individual essential oils (Meng et al., 2015, Carroll et al., 2011). However, they were found to be ineffective, especially in comparison to synthetic agents and products. It is probably because individual essential oils are not effective for repellency that Pyranha and Outsmart did not differ from the tap water control. They had few essential oils (Pyranha: Geraniol, Peppermint oil, Clove oil; Outsmart: Geraniol, Peppermint oil) compared to Ultrashield Green, and ticks were not repelled by them. Ultrashield Green has an extensive list of essential oils: Geraniol, Clove oil, Citronella oil, Rosemary oil, Lemongrass oil, Cedar oil, and Thyme oil. It has 4-5 more essential oils in it than Pyranha and Outsmart do. It is inferred that the combination of many essential oils is what is repellent. Because of the large number of essential oils used, the odor of Ultrashield Green was also significantly stronger than the other two products used. This is important to keep in mind when using it around livestock who are sensitive to strong odor. More research would need to be done to see if any of the essential oils in Ultrashield Green individually are effective at repelling ticks, or if it is the combination of so many essential oils which is repellent. Meng et al., 2015 found that combinations of essential oils had synergistic effects against mosquitos and speculated that the same could potentially happen for ticks. More research needs to be done on combinations of essential oils rather than individual ones as an option for natural repellents against ticks.

Ticks used for this study were expected to be more active than they were. As stated, the Lone Star tick is known for being an aggressive species and more willing to climb because of that. The ticks in this study were calmer than expected and did not move much with the exception of fleeing from Ultrashield Green. To observe the locations of ticks, observers had to lean over the arenas at close proximity. Carbon Dioxide is attractive to ticks as it helps them find a host. It was thought that breathing around the ticks in close proximity would stimulate them enough to induce meal seeking activity. However, a number of things could have caused the ticks to be less active and not be meal seeking. Air drafts and stage of life could have affected their activity levels. It could just be that the particular colony they came from were a less active colony. More active ticks may have given clearer results of repellency. That being said, more trials could have also given clearer results. Only four trials for each product were ran for this study. Other studies are known to have used up to forty trials (Machtinger et al., 2017). More trials would have given more data to analyze, and a more accurate repellency status would have been given. Other trials were performed to determine if the products were affecting each other during each trial as the arenas were in close proximity together. No difference was found in repellency between trials with the arenas close to each other and trials where they were done individually. There was also no difference found between male and female ticks.

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