Dodet B, Fooks AR, Müller T, Tordo N, and the Scientific & Technical Department of the OIE (eds): Towards the Elimination of Rabies in Eurasia. Dev Biol. Basel, Karger, 2008, vol 131, pp 145-150.

Bait Acceptability for Delivery of Oral Rabies Vaccine to Free-ranging Dogs on the Navajo and Hopi Nations

D. Bergman[1], S. Bender[2], K. Wenning[1], D. Slate[1], C. Rupprecht[3], C. Heuser[1], T. DeLiberto[1]

1 Animal and Plant Health Inspection Service, Wildlife Services, United States Department of Agriculture
2 Navajo Nation, Chinle, AZ, USA
3 Centers for Disease Control and Prevention, Atlanta, GA, USA

Key Words: baits, dogs, oral vaccination, rabies

Abstract: In many areas of the world, only 30 to 50% of dogs are vaccinated against rabies. On some US Indian Reservations, vaccination rates may be as low as 5 to 20%. In 2003 and 2004, we evaluated the effectiveness of commercially available baits to deliver oral rabies vaccine to feral and free-ranging dogs on the Navajo and Hopi Nations. Dogs were offered one of the following baits containing a plastic packet filled with placebo vaccine: vegetable shortening-based Ontario slim baits (Artemis Technologies, Inc.), fish-meal-crumble coated sachets (Merial, Ltd.), dog food polymer baits (Bait-Tek, Inc.), or fish meal polymer baits (Bait-Tek, Inc.). One bait was offered to each animal and its behaviour toward the bait was recorded. Behaviours included: bait ignored, bait swallowed whole, bait chewed and discarded (sachet intact), bait chewed and discarded (sachet punctured), or bait chewed and consumed (sachet punctured). Bait acceptance ranged from 30.7% to 77.8% with the fish-meal-crumble coated sachets having the highest acceptance rate of the tested baits.

Introduction

Dogs are often responsible for transmitting rabies to humans due to their presence in the normal human environment and close relationship with people. Dog rabies has been controlled in many countries by parenteral vaccination and the control of free-ranging animals [1]. Dog rabies control in many parts of the world, however, remains a challenge due to factors such as a lack of interest, cost or availability of effective vaccines, and cultural differences in dog ownership. In many cultures, dogs

are not subject to movement restrictions by their owners and have little access to routine veterinary care, including annual vaccinations.

Oral vaccines and baits have been used to control rabies in wildlife such as raccoons (*Procyon lotor*) [2,3], gray foxes (*Urocyon cinereoargenteus*) [4], red foxes (*Vulpes vulpes*) [5], and coyotes (*Canis latrans*) [6] in North America. Baits and vaccines for oral vaccination programs targeting wildlife are potential adjunct procedures to address rabies control in dogs, and may be useful in targeting free-ranging dogs which could not otherwise be handled for parenteral vaccination [1,7]. Many baits and oral vaccine delivery systems have been tested with dogs in various parts of the world [1,8-14]. Further study is needed, however, to develop safe and cost effective oral vaccine delivery systems. The World Health Organization recommends that "hand-out" techniques, along with the retrieval of baits and bait fragments (if not consumed), be used for initial field trials [7]. The objective of this project was to evaluate the effectiveness of commercially available bait matrices for the delivery of oral rabies vaccine to free-ranging dogs on the Navajo and Hopi Nations. Determining acceptable baits is the first step in conducting field trials testing the effectiveness of delivering oral rabies vaccine to dogs.

Materials and Methods

Four commercially available bait matrices were evaluated: a vegetable shortening-based and coated blister pack, i.e., the Ontario slim (Artemis Technologies, Inc., Guelph, Ontario, Canada), a fish-meal-crumble coated sachet (Merial, Ltd., Athens, GA, USA), a dog food polymer (Bait-Tek, Inc. Beaumont, TX, USA) and a fish meal polymer (Bait-Tek). No additional attractants were added to the bait matrices. The Bait-tek baits and the Merial Ltd. bait included the same plastic sachet produced by Merial, Ltd. which was filled with placebo vaccine (water). These baits and sachets are the same as those used in the oral rabies vaccination (ORV) programs in the United States and Canada, however, the sachets in this study contained only water.

Bait trials were conducted from March-April 2003 and April-May 2004. Small groups of 2-4 individuals, including at least one representative from either the Navajo or Hopi Nations, hand-baited as many dogs as possible at each site. Locations where baits were offered on the Navajo Nation included Chinle, Many Farms, Pinon, and Lukachuka. Baits were offered to feral dogs on the Hopi Nation at First Mesa, Second Mesa, and Villa.

Each dog was offered only one bait and its behaviour was observed and recorded into one of five categories: bait untouched, bait swallowed whole, bait chewed and discarded (sachet intact), bait chewed and discarded (sachet punctured), or bait chewed and consumed (sachet punctured). All efforts were made to bait each dog only once and observe uptake. Any uneaten and discarded baits were retrieved. All data from each bait type were combined for analysis. Chi-squared contingency tests were used to analyze the data.

Results

A total of 741 dogs were offered one of the placebo baits. Acceptance of the bait matrices ranged from 30.7% with the dog food polymer to 77.8% with the fish-meal-crumble coated sachet, as measured by the proportion of dogs that consumed the baits (Table 1). Data collected for each dog handling behaviour was combined to ensure that we did not violate the cell rule of having at least five responses in each cell (Table 1). Thus, for analysis the data was combined into two functional response categories; handled with potential oral contact with placebo vaccine (chewed and discarded – sachet punctured; chewed and swallowed – sachet punctured) or handled without potential oral contact with placebo vaccine (untouched; swallowed whole; chewed and discarded – sachet intact) (Table 1). The combining of data elucidates how effective each bait was at delivering a potential vaccine. A

chi-squared analysis indicated significant differences in acceptance among the four baits tested ($\chi^2 = 52.09$, df = 3, $P \leq 0.001$) using the two functional responses.

Further data analysis showed no significant difference in the functional response to the polymer baits (fish meal vs. dog food) ($\chi^2 = 0.95$, df = 1, $P \leq 1$) (Table 1). The fish meal polymer was the only bait used across years and there was no significant difference between years ($\chi^2 = 0.09$, df = 1, $P \leq 1$). There was no significant difference by the dogs in their functional response to the dog food polymer ($\chi^2 = 1.48$, df = 1, $P \leq 1$), fish meal polymer ($\chi^2 = 0.76$, df = 1, $P \leq 1$), or the coated sachets ($\chi^2 = 0.072$, df = 1, $P \leq 1$) with dogs on Hopi vs. the Navajo Nation. Therefore, the data from the polymer, Nations and years were combined for further analysis.

The functional response to the Ontario Slim was significantly reduced as compared to the polymer baits ($\chi^2 = 14.31$, df = 1, $P \leq 0.001$). The feral dogs showed a significant difference by preferentially selecting the coated sachet over the Ontario Slim ($\chi^2 = 51.21$, df = 1, $P \leq 0.001$) and over the combined polymers ($\chi^2 = 25.00$, df = 1, $P \leq 0.001$).

Discussion

Ideally, a comprehensive vaccination program to control dog rabies should reach a majority of the dog population within a relatively short period of time (a few weeks) to break the chain of transmission [1,7]. To reach 75% of a given dog population with oral rabies vaccine, the bait matrix must be highly accepted and dogs must handle the bait in a way such that the vaccine is administered into the oral cavity. The fish-meal-crumble coated sachet was preferred significantly more than other bait matrices. Most dogs chewed the bait in such a way that the placebo vaccine was administered into the oral cavity. Moreover, our data suggests that this bait is at the 75% threshold to potentially reach a majority of the dog population needed to break the chain of transmission.

Sachets containing the vaccinia-rabies glycoprotein recombinant virus vaccine have not been field tested with dogs, but they have been used extensively in ORV programs targeting raccoons and gray foxes in North America [15]. Numerous safety and efficacy trials have been conducted with vaccine-laden sachets, which ultimately resulted in the licensing of Raboral V-RG ® by Merial Ltd. which remains the only licensed oral rabies vaccine available in the USA. Therefore, there is little safety concern for baits developed using the sachet containing Raboral V-RG ®. In addition, the automated process used to manufacture and coat the sachets provides a cost-effective bait and vaccine delivery system for use in ORV programs in the USA.

The purpose of using baits is to increase the ability to deliver a vaccine into the oral cavity of dogs. Baits which are manipulated in such a way that the vaccine-containing sachet is not punctured are not effective at delivering vaccine to the oral cavity. The Ontario Slim bait was poorly accepted by the dogs as shown by the high percentage of dogs ignoring the bait when presented and the low proportion of dogs with potential oral contact with the placebo vaccine (Table 1).

Furthermore, this bait is not licensed for vaccine delivery in the USA. Given that the maximum proportion of dogs that could have had oral contact with the vaccine using the Ontario Slim was only 37.9%, it would not be a good candidate for committing resources towards licensing in the USA based on the performance observed in this study and the availability of better performing licensed products.

Table 1: Oral bait acceptance by free-ranging dogs on the Navajo and Hopi Nations.

Bait	Untouched	Swallowed whole	Chewed and discarded (sachet intact)	Chewed and discarded (sachet punctured)	Chewed and swallowed (sachet punctured)	Total baits consumed*	Handled without oral contact with placebo vaccine**	Handled with potential oral contact with placebo vaccine***
Ontario slim	70/161 (43.5%)	8/161 (5.0%)	22/161 (13.7%)	16/161 (9.9%)	45/161 (27.9%)	53/161 (33.0%)	30/161 (18.6%)	61/161 (37.9%)
Dog food polymer	68/257 (26.5%)	17/257 (6.6%)	35/257 (13.6%)	75/257 (29.2%)	62/257 (24.1%)	79/257 (30.7%)	52/257 (20.2%)	137/257 (53.3%)
Fish meal polymer	38/188 (20.2%)	3/188 (1.6%)	38/188 (20.2%)	31/188 (16.5%)	78/188 (41.5%)	81/188 (43.1%)	41/188 (21.8%)	109/188 (58.0%)
Coated sachet	21/135 (15.5%)	5/135 (3.7%)	7/135 (5.2%)	2/135 (1.5%)	100/135 (74.1%)	105/135 (77.8%)	12/135 (8.9%)	102/135 (75.6%)

* total baits consumed = number of baits swallowed whole + number of baits chewed and swallowed
* * Baits handled without oral contact with placebo vaccine = number of baits swallowed whole + number of baits chewed and discarded with the sachet intact. These behaviours were lumped because, although the bait was handled, it was not handled in such a way that would result in a potential vaccination of the dog.
* * * Baits handled with potential oral contact with placebo vaccine = number of baits chewed and discarded with the sachet punctured + number of baits chewed and swallowed with the sachet punctured. These behaviours were lumped because a dog handling a bait in such a way to have oral contact with the placebo vaccine could result in potential vaccination of that dog.

A review of the literature suggests that attractants added to commercially available baits could increase their acceptability to dogs. In Egypt, Mexico, and the USA, Linhart et al. [13] found that dogs preferred poultry, beef tallow, cheese, eggs and a proprietary product over fish meal polymer baits. Corn et al. [14] found that dogs in Guatemala preferred poultry flavoured baits over other varieties tested. The acceptance rates in their study for sachets, dog food polymer, and fish meal polymer baits with poultry attractants were proportionally higher than the same baits with other attractants or without additional flavours added [14]. In addition, baits with poultry attractants had acceptance rates up to 9.3% higher than what this study found with the fish-meal-crumble coated sachet commercially produced by Merial, Ltd. for use in the raccoon ORV programs in the USA. A simple substitution in the coating on the sachets (from cod liver oil and fish-meal crumbles to poultry oil and poultry crumbles) could potentially increase acceptance rates for coated sachet on the Navajo and Hopi Nations and maintain the acceptance rate above the 75% threshold.

Acknowledgements

We thank the Navajo Nation Veterinary and Livestock Program and the Hopi Office of Veterinary Services for assisting with the bait distribution and data collection activities.

Disclaimer

Use of trade names is for comparison purposes only and does not constitute endorsement of the USA Government. This report reflects the views of the authors and is not necessarily representative of their institutions.

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Dr. David Bergman, USDA/APHIS/WS, 8836 N 23 Ave., Suite 2, Phoenix, Arizona 85021, USA.
E-mail: David.L.Bergman@aphis.usda.gov