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Short Communication

Spraying food sources with pyrethroid to control peridomestic triatomines

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ABSTRACT

Introduction: We attempted to supplement traditional insecticide spraying by treating peridomiciliar food sources with a powder formulation. **Methods**: Two groups of houses were treated with deltamethrin suspension concentrate (SC), one of which had its primary peridomestic food sources treated with deltamethrin 2P. **Results**: *Triatoma brasiliensis* was the most commonly captured triatomine. Birds, dogs and rodents were the major food sources identified by the precipitin reaction; 554 domestic animals received powder treatment. A sharp reduction in infestation rates was observed in the two groups up to 360 days after spraying. **Conclusion**: The combination SC + 2P did not improve the control of triatomines.

Keywords: Chagas Disease. Epidemiology and vector control.

The strategy for Chagas disease control primarily consists of the interruption of vectorial transmission through the application of insecticides with residual effects in infested houses and peridomestic structures. In 1991, because of the Initiative of the Southern Cone Countries (Argentina, Brazil, Chile, Paraguay and Uruguay), the Chagas Disease Control Program/Brazilian Health Service (CDCP/FUNASA) began to prioritize areas of *Triatoma infestans* Klůg 1834 infestation[1], which caused Brazil to receive a certification of triatomine vector transmission elimination[2]. However, in Brazil, there are 62 recognized species of triatominae[3], and the occurrence of native triatomine species that sporadically invade or reinvade human dwellings constitutes a major challenge for successful vector control[4].

In the northeastern part of Brazil, *T. brasiliensis* Neiva 1911 is the major insect vector. The Chagas Disease Control Program (CDCP) is capable of promoting the reduction of triatomine populations in an artificial environment. However, due to its widespread occurrence in the natural environment, the proximity of houses to these silvatic triatomine populations and the capacity of this species to adapt to environmental conditions and to the hosts that are present in the artificial environment, intradomicile recolonization often occurs after spraying[5]. Among the factors that could influence the process of recolonization of the houses and peridomiciles are the following: I) a probable transience of the insecticides due to the high temperatures of the northeastern region; II) the difficulty of ensuring that the insecticide accesses the hiding places where the triatomines lodge themselves, allowing for insect survival; III) the possibility of operational failures in spraying; and IV) the possibility of the triatomines developing resistance to pyrethroids, as observed in other countries[6,7] and in Brazil[8].

The peridomestic environment represents an important target for the control of various triatomine species. In Brazil, residual triatomine foci are primarily found on peridomestic livestock, which represent a serious challenge to the national vector control program[1]. The transference of responsibility for vector control activities to Brazilian municipalities caused discontinuity in the CDCP's efforts. Thus, it is critical that municipalities assume their role in the National Health System to guarantee the continuity of triatomine control[2]. However, it is also crucial to develop methodologies that involve both the location and control of residual foci. Deltamethrin, for which a large amount of experience and information exists, was the first pyrethroid introduced into the CDCP/FUNASA control program. Its long residual action indoors was proven in the States of Minas Gerais[9], Goiás[10] and Ceará[5] under varying climatic regimes and different housing construction patterns. As with the other pyrethroids, the most appropriate formulation for triatomine control is the suspension concentrate because in this formulation, the number of molecules remaining on the wall surfaces is greater; therefore, its activity is maintained for longer periods. Deltamethrin powder (2P) is a formulation that is completely insoluble in water. The 2P formula is commercially available and indicated for environments where aqueous formulations are not applied, such as animal nests to combat ectoparasites. Applied directly, the final given dose is very low, which enables the safe treatment of animals. The dusting of chickens with approximately 5-10g of talc does not interfere with the consumption of the animal, even on the same

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day as the application of the product, because the dose capable of producing toxicity in mammals via oral administration is 1,000mg/kg body weight. Thus, the aim of this study was to assess whether the additional dusting of major food sources with deltamethrin 2P, in addition to traditional spraying, would help to reduce insect contact and would thus reduce the infestation and peridomestic triatomine density.

The work was conducted in Tamboril district, which is located 301.2km from Fortaleza, Ceará, Brazil. Twenty sites were subjected to infestation research following the methodology employed by the CDCP (manual capture, 30' inside the house and 30' out into the peridomicile). The sample was composed of the infested domiciliary units, which were divided into two randomly selected groups. After the preliminary capture to determine the infestation rates, the groups received different treatments with insecticides. In both groups, the infested domiciliary units were sprayed with a suspension concentrate (SC) of deltamethrin at a dose of 25mg ai/m^2, but one of the groups (56 houses) also had its major food sources (dogs, chickens, ducks, turkeys) and bird nests dusted with deltamethrin powder (10g of talc/kg body weight), as recommended by the manufacturer. The other group (the control) included 62 infested houses. Entomological data were collected to determine the infestation rates: intra- and peridomestic triatomines were captured 30 days after spraying and at 3, 6, 9 and 12 months after spraying using the same methodology that was used before spraying. The identification of the triatomines and examinations for *Trypanosoma cruzi* infection were performed at the pre-treatment time point and at the final time point; at the 3rd, 6th and 9th month time points, the insects were identified (species and instar) in the field, without capture, to prevent interference with the process of rebuilding the triatomine population after spraying.

To identify the food source, the stomach contents of triatomines that were captured before spraying were identified by the precipitin reaction. The antisera preparation, titer determination and specificity were performed according to Lorosa[11]. The blood sources investigated were anti-human (1:15,000), rodent (1:15,000), bird (1:10,000), opossum (1:12,000), dog (1:15,000) cat (1:12,000), steer (1:15,000) and horse (1:13,000).

The infestation results of the intradomicile, peridomicile and domestic units (DUs) before and after treatment with deltamethrin are shown in **Table 1**. The infestation rates at the pre-treatment time point were 37.1% and 48.4% for the DUs treated with either SC + 2P or only SC, respectively. At each evaluation, a number of houses were lost for different reasons (closed house, painting or washing the walls). The intradomicile readings remained negative up to 270 days after the spraying, regardless of the treatment used. The location of insects in the peridomiciles was always associated with piles of bricks, tile or wood, chicken coops, barns, stables or perches.

Two hundred forty-four insects were captured at the pre-treatment time point. Of these, 60 adults and 61 nymphs of *T. brasiliensis* were captured in the DUs that were treated with SC, and 57 adults and 66 nymphs were captured in DUs treated with SC + 2P. *T. cruzi* infection was identified in 0.4% of the 231 examined triatomines. In the post-treatment survey, only two specimens were captured in the intradomicile environment, an adult *T. brasiliensis* and an adult *Panstrongylus lutzi* Neiva & Pinto 1926, both at 360 days after spraying.

Altogether, 554 domestic animals and 55 bird nests were treated with deltamethrin 2P, in addition to the traditional DU treatment with SC (**Table 2**). Throughout the course of the study, no difference was identified between groups with respect to the percentage of infestation and peridomestic triatomine density (χ^2 test, $p>0.05$).

TABLE 1 - Infestation of the domestic units in Tamboril, State of Ceará, before and after treatment with deltamethrin (SC 25mg ai/m^2 and/or powder 10g/kg weight).

Treatment	Evaluation	Treated (n)	DU	I	P	% DU	% I	% P
Spraying with SC	pre-treatment	128	62	32	37	48.4	25.0	28.9
	30 days	60	1	0	1	1.7	0.0	1.7
	90 days	61	3	0	3	4.9	0.0	4.9
	180 days	53	3	0	3	5.7	0.0	5.7
	270 days	46	2	0	2	4.3	0.0	4.3
	360 days	44	3	1	2	6.8	2.3	4.5
SC+2P	pre-treatment	151	56	22	41	37.1	14.6	27.2
	30 days	55	4	0	4	7.3	0.0	7.3
	90 days	55	2	0	2	3.6	0.0	3.6
	180 days	40	6	0	6	15.0	0.0	15.0
	270 days	37	3	0	3	8.1	0.0	8.1
	360 days	35	4	1	4	11.4	2.9	11.4

DU: domestic unit = intradomicile + peridomiciliar structures; I: intradomicile; P: peridomicile; SC: suspension concentrate.

TABLE 2 - Food sources present in dwellings and dusted with deltamethrin 2P in the district of Tamboril, State of Ceará, Brazil.

Host	Existing	Treated	
		n	%
Chickens	819	438	53.5
Ducks	78	34	43.6
Turkeys	47	40	85.1
Dogs	51	42	82.4
Nests/birds	55	55	100.0
Total	1,050	609	58.0

TABLE 3 - Feeding sources identified by the reaction of precipitin in a sample of *Triatoma brasiliensis* captured in the district of Tamboril, State of Ceará, before the deltamethrin treatment.

Food sources	Hosts	Total	
		n	%
1	bird	40	42.5
	dog	6	6.4
	opossum	4	4.3
	rodent	16	17.0
2	bird/opossum	3	3.2
	bird/horse	2	2.1
	bird/rodent	4	4.3
	bird/dog	4	4.3
	rodent/dog	2	2.1
	horse/dog	1	1.1
3	bird/dog/opossum	1	1.1
	bird/opossum/rodent	1	1.1
	did not react	10	10.6
Insect total		94	100.0

The results of the blood meal identification were based on 94 *T. brasiliensis* specimens. In total, 10 (10.6%) samples did not react to any of the antisera tested, 66 (70.2%) reacted to a single source, 16 (17%) to two sources and two (2.1%) to three sources (**Table 3**). Birds were the most common food source. By grouping the insects that fed on a single source with those that fed on two or more, the most common source was bird blood, found in 45 (47.9%) samples, followed by rodent blood, found in 23 (20.2%) samples. Other food sources included 10 (10.6%) samples with dog blood, two (2.1%) with horse blood and six (6.4%) with opossum blood.

Recent advances in the prevention and control of Chagas disease have brought both new challenges and a new examination of the epidemiological disease characteristics. The Brazilian program is in the surveillance stage, and in this respect, efforts should focus on maintaining results, consolidating the control of residual foci and preventing the establishment of new foci of vectorial transmission. However, the epidemiology of Chagas disease is extremely complex due to the presence of native species that exist in close association with wild reservoirs. In this context, *T. brasiliensis* is one of the most important species in the transmission of Chagas disease in Brazil and is the major vector species in the northeast.

In this study, during the pre-treatment research, we found that 32 (25%) and 22 (14.6%) of houses were infested. The application of pyrethroid ensured that the dwellings were free of infestation for up to 270 days after spraying. Only after 360 days were two homes recorded as infested: one in the group receiving treatment with SC and the other in the group treated with SC + 2P. These data corroborate data from other studies on the large impact and long residual effect of pyrethroid[10,12], even under the adverse conditions of the Ceará Caatinga, as they kept indoor areas infestation-free for up to nine months.

The aspect of these results that deserves the most attention is the slowness of the peridomestic reinfestation, unlike observations from other experiments. These results can be attributed to the excellent quality of the spraying or the environmental characteristics, which are perhaps connected to the poorest wild river-heads in the region. Previous studies in the State of Ceará show that from the fourth month after treatment of infested houses with pyrethroid, this triatomine species is captured primarily in peridomestic environments[5,13], possibly due to the success of reinvading wild populations that inhabit stones that are very close to the houses. Moreover, triatomine control in peridomiciles is very limited due to their complex organization and the difficulty of spraying all sites in which these vectors can lodge. Many places do not receive the insecticide at the time of spraying, enabling the survival of insects that can then re-infest the area during the months following the spraying[5,14]. Another aggravating factor, which is particularly common in the northeast, is the constant renovation of the peridomicile[13]. This circumstance creates potential shelters for triatomines that are completely unprotected by insecticide and enables the establishment of new foci of infestation. Considering these factors, we proposed testing the dusting of the major food sources of triatomines with deltamethrin 2P to compensate for the limitations presented by the peridomiciles and ultimately to strengthen the vector control strategies. However, we did not observe any difference between the two treatments. The data do not suggest decreased contact with the food source that could promote a reduction in triatomine infestation or density. This finding is likely due to the low permanence and stability of the product in the environment, which should be increased when in contact with the skin of domestic animals that exhibit different behaviors (swimming, ground scratching, skin scratching, etc.).

The results of food source identification reveal a strong association between *T. brasiliensis* and birds. In the natural environment, these triatomines are mostly found on rocks. In the peridomicile, in turn, chickens are common and travel freely in the yard. Considering the proximity between these environments and the high availability of these animals, we can

assume that these factors have contributed to the precipitin test results. Among the investigated domestic animals, dogs are the second-most important food source for the vectors present in this locality. Opossums and rodents, which are extremely important hosts because they are a link between wild and peridomestic cycles[15], are also important food sources for these vectors. However, at the time of this study, none of the above-mentioned hosts played an important role in vector infection, as only one specimen (0.4%) contained a flagellate in its intestinal contents.

Thus, we conclude that the application of insecticide powder to the major food sources for the triatomines did not influence the process of DU infestation when compared to the control. In the intradomicile, the spraying rate was sufficient to keep the houses free of triatomines.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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