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MANAGEMENT OF GERMAN COCKROACHES: TIME EFFORT OF USING BAITS AND INSECTICIDAL SPRAY

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Abstract Infestations of German cockroaches (*Blattella germanica*) are commonly controlled using gel baits. However, cockroach control is still carried out nowadays using insecticidal sprays. In this study, the use of a gel bait (0.6% Indoxacarb) and an insecticidal spray (2.49% Deltamethrin) applied by a professional pest controller in refugee homes in Berlin was compared, focusing on the time effort of pre-treatment and treatment and the efficacy up to 6 weeks after treatment. No pre-treatment was necessary using gel baits; the time effort was 0.90 min/m^2 (mean) compared to the insecticidal spray, where the mean pre-treatment and treatment time effort was 2.32 min/m^2. Both treatments led to sufficient cockroach reduction of 99.7% using the gel bait and 95.7% using the insecticidal spray after 6 weeks. However, gel bait application is simple; no pre-treatment is needed, and residents can re-enter their home directly after treatment compared to insecticidal sprays, where pre-treatment and treatment needs about 2.5x more time, and residents have to wait several hours (2-4 h depending on the situation) before re-entering the treated areas (apartments, houses, restaurants) for safety reasons. Furthermore, all furniture and belongings must be returned to their place which might need the same time as pre-treatment.

Key words field study, cockroach control, Indoxacarb, Deltamethrin

INTRODUCTION

Infestations with German cockroaches (*Blattella germanica*) are a significant problem. Cockroaches are mechanical vectors and can spread various pathogens such as bacteria (e.g., *Escherichia coli*, *Salmonella spp*., *Streptococcus aureus*), fungi (e.g., *Candida* spp., *Penicillium* spp., *Aspergillus* spp., *Acremonium* spp.), helminths (e.g. *Ascaris lumbricoides*, *Trichuris trichiura*, *Taenia* spp., *Toxocara canis*), protozoa (e.g. *Entamoeba histolytica*, *Giardia duodenalis, Balantidium coli*) and viruses (e. g. sapovirus, rotavirus) (Ash and Greenberg, 1980; González-García et al., 2017; Hamu et al., 2014; Liu et al., 2024; Pai et al., 2003a; Pai et al., 2003b; Pai et al., 2015). Multi-resistant bacteria have also been detected on their cuticle (Fathpour et al., 2003; Pai et al., 2005; Pai, 2013). In addition, their feces can trigger allergies and asthma, especially in severe infestations (Huss et al., 2001; Gore and Schal, 2005). German cockroaches reproduce quickly; their droppings, egg cases, and shed skin contribute to unsanitary conditions. Their presence causes discomfort and anxiety for many people. Cockroaches hide in cracks and crevices and can be resistant to some pesticides. Their health, sanitation, and psychological impacts make managing German cockroach infestations challenging. Several products against cockroaches are on the market, and baits and sprays are mainly used. Contact insecticides can lead to a cockroach infestation being classified as eradicated, but some cockroaches are driven away by the often repellent effect of the products. These may return later, meaning no long-term eradication is achieved (Rust and Reierson, 1978;

Miller and Meek, 2004). In recent decades, integrated pest management (IPM) concepts have become increasingly important for cockroach control (Radcliffe et al., 2009). This means recognizing structural or hygienic deficiencies and remedying them wherever possible. Permanent monitoring is essential to detect infestations as early as possible (e.g., glue traps). Any food sources and hiding places for cockroaches must also be eliminated. Residents or employees in affected buildings must be trained to participate actively in these measures (Rivault and Cloarec, 1995). IMP is associated with higher effort. In comparative studies, however, the costs were found to be roughly the same or even lower than conventional and repeated event-related control measures, especially in the long term (Brenner et al., 2003; Wang and Bennett, 2009).

In Berlin, Germany, there have been many centrally organized refugee shelters for several years, which provide different types of rooms for refugees. These buildings often have significant structural differences and include individual rooms for several single refugees who use central sanitary facilities and kitchens. There are also apartments for families in which bathrooms and kitchens are integrated. Nevertheless, the problem with all types of accommodation is that staff and refugees only spend a limited amount of time in the respective accommodation, and the inventory is not always maintained. In addition to these challenging conditions, there is a permanent lack of sufficient financial resources. This makes comprehensive IPM, including staff training the removal of potential hiding places, and the prevention of reinfestations more difficult. Furthermore, there is no constant monitoring in most accommodations, and cockroach infestations are often only discovered when residents or staff see cockroaches running around. Only then will glue traps be handed out for confirmation. Also, the spread of infestations within the building through new food or refugees, cockroach migration, rearranging furniture, etc., is a constant problem. Irrespective of the pest controller's recommendation, spray-only treatments of entire accommodations are also repeatedly ordered. In this study, the use of a gel bait and an insecticidal spray applied by a professional pest controller in refugee homes in Berlin was compared. The focus was on two points: the time effort required for pre-treatment and treatment and the efficacy of treatment up to 6 weeks after treatment.

MATERIAL AND METHODS

To compare two cockroach treatment methods, Advion cockroach gel bait (Syngenta) and K-Othrine Partix (Envu Germany) as an insecticidal spray were used against the German cockroach *Blattella germanica* in a field study. The infestation level was determined using glue traps before treatment. The treatment was carried out by a professional pest controller. The time effort of the pre-treatment (cleaning up, rearranging furniture and belongings, preparing the product, putting on protective clothing) and treatment (setting gel points, spraying the surfaces) was documented. The amount of time spent cleaning up after treatment was done by the residents and not documented. The efficacy was determined by counting the number of cockroaches on the glue traps up to six weeks after treatment.

For each treatment method, five apartments in three different community accommodations in Berlin were used. Three glue traps per apartment were placed to assess the cockroach infestation level three to five days before treatment.

Table 1: Overview of the rooms treated in this study.

Product	Test Site	Start date	Study room no.	Residents	Bathroom / kitchen	Room size [m^2]
Advion Cockroach Gel	Schwalbenweg	08.04.24	1	0	yes / no	32
			2	3	yes / no	24
			3	0	yes / no	33
	Falkenberger Straße	22.04.24	4	3	yes / yes	25
	Lindenberger Weg	29.04.24	5	6	yes / yes	45
K-Othrine Partix spray	Schwalbenweg	08.04.24	6	2	yes / no	24
			7	0	yes / no	24
			8	2	yes / no	21
	Lindenberger Weg	29.04.24	9	1	no / no	16
		17.05.24	10	2	no / no	16

The gel bait was applied at the five test sites according to the label claim with a dosage of 0.5 g/m^2 ground area of the whole apartment. However, the gel spots were mainly applied where cockroaches rest, hide, and forage: cracks and crevices, behind refrigerators, under the sink, in edges, and along skirting boards. Bait stations were set up in the kitchens of two apartments, as children live in these apartments.

The Deltamethrin-containing spray was applied in the five test sites as low-pressure spray according to the label claim (1:200, 50 ml/m^2) on surfaces (cupboards, fridges, under beds) along skirting boards and walls. Before application, apartments had to be prepared (tidied up, belongings and furniture rearranged and covered).

RESULTS AND DISCUSSION

The mean treatment time was nearly the same for both products. It took 0.90 min/m^2 using Advion gel and 1.01 min/m^2 using K-Othrine Partix spray.

However, Advion gel treatment could be done without pre-treatment, regardless of whether the room was inhabited. Directly after treatment, the residents could return to their rooms and had no effort to clean up (Table 2).

K-Othrine Partix spray treatment needed pre-treatment. Only one room (no residents) was prepared within 5 min. In all other rooms, even in the smaller ones with a size of about 16 m^2, pre-treatment took at least 25 min before treatment (Table 2). The mean pre-treatment time was 1.31 min/m^2. After treatment, residents had to wait 4 h before they were allowed to return to their apartment.

In this study, the pest controller prepared the spray treatment. This served to find out how much time these measures require. Usually, the resident is given precise instructions on how everything should be prepared. Unfortunately, these are not always fulfilled, and the pest controller cannot start work immediately, or the chances of success are lower due to poor preparation. The post-treatment time of the residents was not determined, but it can be assumed that the effort was about the same as the pre-treatment time.

Table 2: Time effort of the two different treatment methods.

Product	Study room no.	Room size [m^2]	Time effort [min]						
			Pre-treatment	Treatment	Total	Pre-treatment time /m^2	Total time / m^2	Mean pre-treatment time / m^2	Total mean time / m^2
Advion Cockroach Gel	1	31.89	n.a.	25	25	n.a.	0.78	n.a.	0.90
	2	24.38	n.a.	15	15	n.a.	0.62		
	3	33.24	n.a.	40	40	n.a.	1.20		
	4	25	n.a.	35	35	n.a.	1.40		
	5	45.47	n.a.	22	22	n.a.	0.48		
K-Othrine Partix spray	6	24.38	35	25	60	1.44	2.46	1.31	2.32
	7	24.38	5	20	25	0.21	1.03		
	8	20.77	32	16	48	1.54	2.31		
	9	16.42	25	20	45	1.52	2.74		
	10	16.34	30	20	50	1.84	3.06		

Both treatment methods showed sufficient insecticide efficacy against German cockroaches. Advion treatment achieved a slightly higher reduction at all evaluation points. Two weeks after treatment reduction was 89.3% using Advion gel and 84.3% using K-Othrine Partix spray (Table 3, Figure 1). After 3 weeks, reduction reached more than 90% for both treatments (Advion: 97.0%, K-Othrine partix: 92.7%). Reduction increased to 99.4% in Advion gel treatments and 97.2% after 4 weeks.

Table 3: Number of cockroaches (total, per day, per trap, per day and trap) before treatment and at all evaluation points.

Product	Study room no.	Before treatment				Week 2 after treatment			
		No. of cockroaches	No. of traps	No. of days for trapping	No. of cockroaches per day & trap	No. of cockroaches	No. of traps	No. of days for trapping	No. of cockroaches per day & trap
Advion Cockroach Gel	1	3	3	3	0.33	2	3	7	0.10
	2	9	3	3	1.00	0	3	7	0.00
	3	341	3	3	37.89	12	3	7	0.57
	4	119	3	4	9.92	107	3	7	5.10
	5	74	3	4	6.17	3	3	7	0.14
K-Othrine Partix spray	6	57	3	3	6.33	7	3	7	0.33
	7	6	3	3	0.67	1	3	7	0.05
	8	28	3	3	3.11	3	3	7	0.14
	9	12	3	4	1.00	10	3	7	0.48
	10	75	3	4	6.25	31	3	6	1.72

Product	Study room no.	Week 3 after treatment				Week 4 after treatment			
		No. of cockroaches	No. of traps	No. of days for trapping	No. of cockroaches per day & trap	No. of cockroaches	No. of traps	No. of days for trapping	No. of cockroaches per day & trap
Advion Cockroach Gel	1	3	3	7	0.14	0	3	7	0.00
	2	0	3	7	0.00	0	3	7	0.00
	3	1	3	7	0.05	0	3	7	0.00
	4	45	3	15	1.00	2	3	6	0.11
	5	11	3	8	0.46	4	3	6	0.22
K-Othrine Partix spray	6	3	3	7	0.14	2	3	7	0.10
	7	1	3	7	0.05	1	3	7	0.05
	8	-	-	7	-	4	3	14	0.10
	9	2	1	8	0.25	0	1	6	0.00
	10	16	4	7	0.57	6	3	8	0.25

Product	Study room no.	Week 5 after treatment				Week 6 after treatment			
		No. of cockroaches	No. of traps	No. of days for trapping	No. of cockroaches per day & trap	No. of cockroaches	No. of traps	No. of days for trapping	No. of cockroaches per day & trap
Advion Cockroach Gel	1	0	3	7	0.00	0	3	8	0.00
	2	0	3	7	0.00	0	3	8	0.00
	3	0	3	7	0.00	0	3	8	0.00
	4	1	3	7	0.05	1	3	5	0.07
	5	1	3	7	0.05	2	3	8	0.08
K-Othrine Partix spray	6	3	3	7	0.14	4	3	8	0.17
	7	0	3	7	0.00	0	3	8	0.00
	8	1	3	7	0.05	-	-	8	-
	9	1	3	7	0.05	1	3	9	0.04
	10	10	4	6	0.42	11	4	7	0.39

Table 3: Number of cockroaches (total, per day, per trap, per day and trap) before treatment and at all evaluation points.

Product	Study room no.	Before treatment				Week 2 after treatment			
		No. of cockroaches	No. of traps	No. of days for trapping	No. of cockroaches per day & trap	No. of cockroaches	No. of traps	No. of days for trapping	No. of cockroaches per day & trap
Advion Cockroach Gel	1	3	3	3	0.33	2	3	7	0.10
	2	9	3	3	1.00	0	3	7	0.00
	3	341	3	3	37.89	12	3	7	0.57
	4	119	3	4	9.92	107	3	7	5.10
	5	74	3	4	6.17	3	3	7	0.14
K-Othrine Partix spray	6	57	3	3	6.33	7	3	7	0.33
	7	6	3	3	0.67	1	3	7	0.05
	8	28	3	3	3.11	3	3	7	0.14
	9	12	3	4	1.00	10	3	7	0.48
	10	75	3	4	6.25	31	3	6	1.72

Product	Study room no.	Week 3 after treatment				Week 4 after treatment			
		No. of cockroaches	No. of traps	No. of days for trapping	No. of cockroaches per day & trap	No. of cockroaches	No. of traps	No. of days for trapping	No. of cockroaches per day & trap
Advion Cockroach Gel	1	3	3	7	0.14	0	3	7	0.00
	2	0	3	7	0.00	0	3	7	0.00
	3	1	3	7	0.05	0	3	7	0.00
	4	45	3	15	1.00	2	3	6	0.11
	5	11	3	8	0.46	4	3	6	0.22
K-Othrine Partix spray	6	3	3	7	0.14	2	3	7	0.10
	7	1	3	7	0.05	1	3	7	0.05
	8	-	-	7	-	4	3	14	0.10
	9	2	1	8	0.25	0	1	6	0.00
	10	16	4	7	0.57	6	3	8	0.25

Product	Study room no.	Week 5 after treatment				Week 6 after treatment			
		No. of cockroaches	No. of traps	No. of days for trapping	No. of cockroaches per day & trap	No. of cockroaches	No. of traps	No. of days for trapping	No. of cockroaches per day & trap
Advion Cockroach Gel	1	0	3	7	0.00	0	3	8	0.00
	2	0	3	7	0.00	0	3	8	0.00
	3	0	3	7	0.00	0	3	8	0.00
	4	1	3	7	0.05	1	3	5	0.07
	5	1	3	7	0.05	2	3	8	0.08
K-Othrine Partix spray	6	3	3	7	0.14	4	3	8	0.17
	7	0	3	7	0.00	0	3	8	0.00
	8	1	3	7	0.05	-	-	8	-
	9	1	3	7	0.05	1	3	9	0.04
	10	10	4	6	0.42	11	4	7	0.39

The highest reduction was achieved at week 5 with both treatment methods (Advion: 99.8%, K-Othrine Partix: 96.2%). At the end of the trial, Advion Cockroach Gel led to a reduction of 99.7%. In 3 apartments, no cockroach was found. In 2 apartments only 1 and 2 cockroaches were still found. In apartments where K-Othrine Partix spray was used, a 95.7% reduction in infestation was achieved. No access was given in one apartment, and the traps could not be checked. In one apartment, no cockroach was found. In 3 apartments 1, 4, and 11 cockroaches were documented.

A new infestation cannot be ruled out at all three trial locations. The number of documented cockroaches may have increased again towards the end, or complete eradication may not have been achieved.

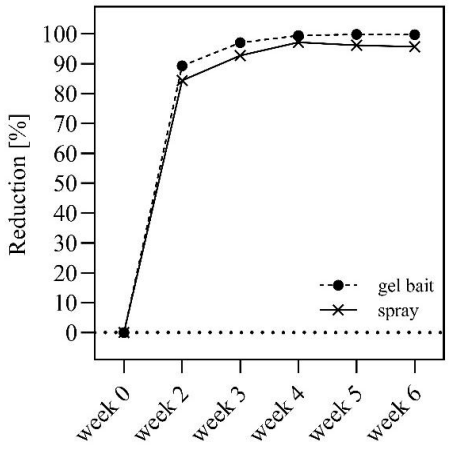

Figure 1: Reduction of cockroaches per trap and per day.

According to the comparative study, various points speak in favor of using gel bait to treat cockroach infestations in refugee homes. The Advion gel bait was highly palatable, and cockroaches were observed foraging directly after the bait offering. Possible newly introduced cockroaches can also be killed with the remaining gel dots because they are still palatable and effective even years later (ArthroScience studies no. AS-P-2022-17 and AS-P-2023-04) and do not need to be cleaned due to the hidden application. There is no need for pre-treatment and post-treatment, and the residents can stay or re-enter their apartments directly after treatment.

Although the insecticide efficacy against German cockroaches was also very high, residents had to wait 4 h after K-Othrine Partix spray treatment before returning to their apartments. Furthermore, the time required to rearrange furniture and belongings after treatment was not documented, but apparently, the effort of the residents was relatively high. After 4-6 weeks, the effectiveness of a spray usually diminishes due to various influences (inhabitants, environment, etc.) so that reintroduced cockroaches are not affected, and a new treatment is necessary. All these points apply to the sprays available by pest controllers to control German cockroaches.

The efficacy of both control methods depends on the collaboration of the residents because the products should not be cleaned away for at least 6 weeks. In the case of the gel dots, it was easy to check whether the residents had left them in place during the follow-up checks; unfortunately, this could not be reliably detected with the spray.

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