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AN ADJUVANT TO ANTICOAGULANT RODENTICIDES: REDUCING RESISTANCE, SECONDARY POISONING OF NON-TARGET SPECIES, AND ENVIRONMENTAL CONTAMINATION IN RODENT CONTROL

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Abstract Restrictions on rodenticide's use, limited number of effective active ingredients, non-target species poisoning, environmental contamination, behavioural adaptations, rodenticide resistance, urbanisation and climate changes are the current challenges in rodent control. These are expected to influence the industry over a large area and for extended timeframe. Current rodent control strategies primarily rely on anticoagulant-based formulations. However, the high bait consumption required for proper level of efficacy poses significant risks of secondary poisoning to non-target species and ecosystems. This study investigates the potential of a novel adjuvant designed to be co-administered with all classes of anticoagulant rodenticides. The adjuvant enhances the bioavailability of the active anticoagulant compound, reducing the quantity of bait needed for effective rodent control. By increasing the bioavailability, it also generates feeding arrest at significantly lower dose required for lethality. Additionally, it decreases the risk of secondary poisoning in non-target species (nocturnal predators, companion animals) by minimizing the residual anticoagulant levels present in the rodent carcass. Laboratory trials confirm the adjuvant's compatibility with various first- and second-generation anticoagulants, demonstrating improved efficacy at reduced bait intake. These findings present a promising step towards safer, more efficient rodent control, potentially lowering ecological impacts while maintaining effective pest management as more environmentally sustainable approach.

Key words Rodenticide resistance, bioavailability enhancement, non-target species

INTRODUCTION

Rodent control remains a critical challenge in urban, agricultural, and conservation settings, where managing rodent populations is necessary to prevent economic losses, disease transmission, and ecological disruptions (Smith et al., 2020). Traditionally, anticoagulant rodenticides have been the primary tool for controlling rodent infestations due to their effectiveness in reducing populations. However, their widespread use has raised significant concerns regarding environmental impact, particularly the risks associated with secondary poisoning of non-target species, including predators and scavengers that feed on poisoned rodents (Jones & Williams, 2018).

One of the primary issues in rodenticide application is the need for high bait consumption to achieve lethal doses, which prolongs exposure times and increases the likelihood of contamination in food chains (Brown et al., 2017). Additionally, the emergence of resistance in rodent populations and bait aversion further complicate effective control efforts (Taylor &

Baker, 2019). Current formulations often require excessive amounts of bait to ensure efficacy, exacerbating the risks associated with both primary and secondary poisoning (Miller & Cooper, 2021). To ensure user safety, in the EU the use of anticoagulants containing active substances of > 30 ppm is restricted to professionals only. Therefore, to support the non-professional market needs a new products with < 30 ppm anticoagulant substance have been developed and registered. However, the decreased concentration of brodifacoum anticoagulant in rodenticide baits may lead to greater accumulation in rodent liver, increasing the environmental risk (Frankova et al., 2024).

A promising approach to mitigating these risks is the use of adjuvants that enhance the bioavailability of the active anticoagulant compound. By improving the bioavailability and increasing the efficiency of the toxicant this solution allows for a significant reduction in the quantity of bait required for effective rodent control. This not only improves cost-effectiveness but also minimizes environmental exposure, lowering the risk of secondary poisoning to non-target wildlife (Johnson & Lee, 2020). Furthermore, enhancing bait palatability and inducing rapid feeding arrest could optimize bait uptake, ensuring that rodents consume a lethal dose more efficiently while reducing prolonged environmental contamination (Harris & Chen, 2023).
This paper explores the challenges posed by traditional rodenticides and highlights the potential of adjuvant in addressing these concerns.

The rodenticide adjuvant is a highly palatable, thixotropic gel formulation containing a microencapsulated compound that enhances the bioavailability of anticoagulant-based rodenticides. It can be applied directly onto the rodenticide or placed in a separate container within a rat bait box, allowing rodents to consume it alongside the bait.
Additionally, the adjuvant may help mitigate neophobia in rodents. The combination of solid and liquid bait increases overall attractiveness, as rodents are particularly drawn to moisture, especially in environments with limited water availability. This factor is expected to become increasingly important due to rising temperatures associated with climate change, which may intensify water scarcity for rodents in certain habitats.

By improving the efficiency of anticoagulant delivery and reducing overall bait consumption, this approach provides a more sustainable and ecologically responsible solution for rodent control, balancing efficacy with minimized environmental impact.The adjuvant enhances the bioavailability of the active compound, allowing for: Lower bait consumption while maintaining lethal efficacy, induction of feeding arrest, reducing the need for prolonged exposure and minimized secondary poisoning risks, as reduced bait intake results in lower residual anticoagulant levels in rodent carcasses.

MATERIALS AND METHODS

To evaluate the impact of an adjuvant on anticoagulant rodenticide efficacy, a controlled free-choice feeding test was conducted. This experiment compared the consumption of a commercially available rodent bait, KO RAT block brodifacoum 25 ppm, with and without the addition of an adjuvant. The study aimed to assess the palatability, consumption patterns, and potential feeding arrest effect of the adjuvant while monitoring its influence on mortality rates and anticoagulant residue accumulation in rodent livers.

The test will be conducted using six Brown rats *(Rattus norvegicus)* including both males and females, maintained on a standard diet with *ad libitum* access to water. The experiment was repeated twice, with three individuals per group to ensure result consistency.
The rodenticide, with and without the adjuvant, will be introduced into bait stations, whilst the consumption will be recorded daily, and bait replenished every 24 hours to ensure continuous availability. Deceased rodents were stored under refrigeration. At the end of the observation period, surviving rats will be euthanized and all rats analyzed for anticoagulant residues in the liver.

RESULTS AND DISCUSSION

Preliminary field trials conducted by PCO teams have demonstrated high efficacy in real-world conditions. The product was applied at an animal feed production site where rodent infestation was confirmed through monitoring data and analysis of fecal contamination. Given the high rodent population, the study aimed to evaluate the adjuvant effectiveness when applied directly onto the rodenticide inside bait stations.

At first control full consumption of bait observed, confirming high rodent activity. Bait was replenished. At the second control 2 days later 60% of the bait consumed, indicating a decline in feeding activity. At the third control zero bait consumption was recorded, whilst rodents were still active, but no further contamination or structural damage was observed.
Moribund rodents were visible, suggesting successful exposure to the treatment.
The initial high consumption of bait suggests intense rodent pressure in the area also confirmed in the initial monitoring.

The progressive reduction in bait consumption in a short period of time indicates that the product induces feeding arrest, preventing further intake while still ensuring lethal effects.
Despite ongoing rodent activity, the absence of new contamination and damage suggests that the product effectively disrupts feeding behavior, reducing the impact of the infestation.
The presence of moribund rodents supports the hypothesis that the product enhances the rodenticide's bioavailability followed by feeding arrest, leading to more effective control with possibly lower environmental impact.

CONCLUSION

The preliminary field results indicate that the adjuvant significantly enhances rodenticide effectiveness, reducing bait consumption over time while still achieving lethal outcomes. Further laboratory studies are needed to quantify its impact on bioavailability and secondary poisoning risks, but initial findings suggest this approach could be a more efficient and environmentally responsible rodent control strategy.

Further laboratory validation is required to quantify the adjuvant's impact on bioavailability, resistance development, and environmental contamination. If confirmed, this approach could provide a safer, more sustainable rodent control strategy.

FUTURE STUDIES

Following successful preliminary results, further studies will be conducted on a larger experimental group to validate the adjuvants long-term efficacy and environmental impact.
This research aims to develop a next-generation rodent control strategy that balances efficacy with ecological responsibility.

Ethical approval: All animal procedures will be conducted in accordance with EU Directive 2010/63/EU for animal experiments, and ethical approval was obtained from the Institutional Animal Care and Use Committee of the Crop Research Institute. The experimental protocol is approved by the Ministry of the Environment of the Czech Republic (permit number MZP/2020/630/243).

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