

ENVIRONMENTALLY SAFE PERFORMANCE OF PRODUCTS FOR MANAGEMENT OF COMMENSAL RODENTS IN SERBIA EKOLOŠKE PERFORMANSE UPRAVLJANJA OMENSALNIM GLODARIMA U SRBIJI

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ABSTRACT

Management of commensal rodents using environmentally safe methods is a current trend in the scientific community. Data provided by the World Health Organization and various sanitation and epidemiological services have shown that rodents destroy around 33 million tonnes of food intended for human nourishment every year. Continued use of chemical rodenticides over a number of years is known to provoke resistance and cause non-target poisoning of animals and people, as well as environmental pollution. This should be prevented by timely redirection to the available methods that are environmentally safe. Several years of our research of the efficacy of different formulations of an environmentally safe product based on sodium selenite (0.1%) in various livestock facilities and food storages have traced a path for environmentally safe management of commensal rodents. Tests have been conducted on populations of brown rat (*Rattus norvegicus*) and house mouse (*Mus musculus*). Rodent numbers were assessed according to EPPO methodology. Product rations of 10-30 g for the mouse and 50-100 g for the rat were offered to rodents in bait boxes. Our data show that baits ready for use (RB) had the highest efficacy of 99% and 96.5% in controlling *Mus musculus* and *Rattus norvegicus*, respectively. In some experiments, however, sodium selenite baits had unsatisfactory efficacy. No accidental poisoning of non-target organisms was recorded in any trial. The results of this research give us a better insight into possibilities for using sodium selenite as an environmentally safe rodenticide on livestock farms and in food storages.

Keywords: Ecologically safe substance; Sodium-selenite; Efficacy; Strategy; Food safety.

REZIME

Upravljanje komensalnim glodarima ekološkim metodama je danas aktuelno u naučnoj javnosti. Podaci Svetske zdravstvene organizacije i higijensko-epidemioloških službi pokazuju da štetni glodari svojim aktivnostima unište 33 miliona tona hrane namenjene ljudskoj ishrani. Utvrđeno je da višegodišnja primena rodenticida hemijskog porekla dovodi do pojave rezistentnosti, zadesnih trovanja životinja i ljudi i zagađenja životne sredine. Zbog toga u što kraćem periodu treba preći na primenu raspoloživih ekoloških mogućnosti kojima bi se sprečile ovakve pojave. Naša višegodišnja istraživanja efikasnosti različitih formulacija ekološkog preparata na bazi aktivne materije Na-selenita (0,1%), u objektima za smeštaj stoke i u skladištima hrane daju smernice za ekološko upravljanje komensalnim glodarima. Testiranja su izvršena na populacijama sivog pacova (*Rattus norvegicus*) i domaćeg miša (*Mus musculus*). Brojnost glodara procenjena je u skladu sa metodama EPPO standarda. Preparati su izlagani u kutijama za izlaganje mamaka u količinama od 10-30 g za miša i u 50-100 g za pacova. Rezultati ispitivanja ukazuju da je najviši nivo efikasnosti u suzbijanju *Mus musculus* i *Rattus norvegicus* od 99%, odnosno 96,5%, zabeležen u eksperimentima sa formulacijom RB, rasuti mamac. Takođe, u pojedinim eksperimentima zabeležena je i nedovoljna efikasnost mamaka na bazi natrijum selenita. Tokom svih ispitivanja nisu zabeležena akcidentalna trovanja neciljanih organizama. Rezultati ovih istraživanja doprinose sagledavanju mogućnosti upotrebe ekološki prihvatljivijeg rodenticida, natrijum selenita, u objektima za smeštaj stoke i u skladištima hrane.

Ključne reči: ekološki činioci, komensalni glodari, efikasnost, selen, bezbednost hrane.

INTRODUCTION

Environmentally friendly rodent pest management control is a first step in organic food production. The use of natural products and organic fertilizers (Jovanović, 2003; Pešić-Mikulec and Jovanović 2003) aims to preserve an ecological balance in the environment. Organic food producers insist on biological control of rodents (Meerburg et al. 2004). Relevant research is based on physiological ecology (Wang and Wang, 2003) which examines the relationship between physiological and ecological parameters.

Rodenticides, most particularly anticoagulants, have had a dominant role in control of rodent pests in the past several decades (Vukša et al., 2011). Numerous legal restrictions for application of many chemical rodenticides and a widespread resistance of commensal rodents to anticoagulants (Quy et al., 1992; 2009; Pelz, 2001) have inspired research, development and use of environmentally safer methods for protection from rodent pests, particularly in livestock facilities and feed storages. At the onset

of the 21st century, an environmentally friendly approach and strategy for managing commensal rodents have gained in significance when control methods are considered (Cowan et al., 2003; Endepols et al., 2003).

The strategy of environmentally safe management of rodents is a concept based on favouring environmentally safe and non-invasive methods that prevent the spreading of rodent pests into an area, and their habitation and survival there. It is primarily applied in systems of organic food production. The first element of this strategy includes preventive measures. They aim at blocking the access of rodents to different facilities and creating unfavourable conditions for them. These measures cannot achieve total eradication of rodents but they can bring their numbers to an economically acceptable level. These measures include removal of old packaging materials (unused cardboard and metal packaging, straw, etc.) (Endepols et al., 2003), setting of barriers (fences some 100 m away from a farm) (Cavia, 2011) and use of repellents. In many facilities, ultrasound and low-frequency devices are used to repel rodents (Buckle and Smith, 1994). Moni-

toring is a second element of this strategy and it is aimed at collecting data on rodent species and their abundance using various techniques: traps, inks, talc or sand substrate and infra-red cameras. Data collected that way can be used to make effective plans for managing rodents and preventing rodent infestation (Singleton et al., 1999;2004a). The third element of this rodent control strategy is based on treatments with rodenticides. Chemical rodenticides are considered the last choice in this strategy for preventing rodents. Our research focused on examining possibilities for using sodium selenite in livestock facilities and food and feed storages. The results are expected to contribute to developing the third element of this strategy based on environmentally safe control of rodent pests.

MATERIAL AND METHOD

Sites

Experiments were conducted in: PIK Zemun storage facility, PK Stari Tamiš storage of seeding material in Pančevo, Nedelj-ković flour storage at Omoljica, PIK Starčevo storage of seed and consumption potatoes, a feed mixing and storage facility of the Zemun Institute of Animal Husbandry, a livestock farm and mini-dairy at Belegiš, and a storage facility for agricultural products and a pig farm at Belegiš.

Products tested

Products containing 0.1% sodium selenite as their active ingredient (Alfa Aesar, France), manufactured by Ad Ciklonizacija, Novi Sad, were examined as the following formulations: bait ready for use (RB), block bait (BB), granular bait (GB), plate bait (PB) and grain bait (AB).

Tests were conducted over a period between 2003 and 2011.

Test methods

Trials were set up according to the method PP 1/114(2) (EP-PO, 1999). Rodent numbers were assessed by census (EPPO, 1999). Baits were laid in bait boxes, in portions of 10-20 g placed at 1-2 m distance for *Mus musculus*, and 50-100 g placed at 5 m distance for *Rattus norvegicus*. The boxes were laid in places of observed rodent movement on the eighth day after the beginning of experiment. The boxes were marked by ordinal numbers, product names and amounts of bait according to HACCP standard. As recommended by Bokelman (1996), a copy of each label was prominently exposed in every facility to warn of a presence of rodenticide. Placebo baits were laid for four days before and after treatment in order to assess rodent abundance. During the ten-day rodenticide treatment, bait uptake was recorded daily and it was refilled as needed. Rodent numbers were calculated based on total bait uptake and the relationship between the lowest and highest amounts of consumed bait, divided by daily requirements of *Mus musculus* and *Rattus norvegicus*. Rodenticide efficacy was calculated using Abbott's formula (Abbott, 1925).

RESULTS AND DISCUSSION

Table 1 shows the efficacy of different formulations of sodium selenite. Based on data collected in this several-year research, the formulation bait ready for use (RB) demonstrated the highest average efficacy of 99% and 96.5% in controlling *Mus musculus* and *Rattus norvegicus*, respectively. Block bait and granular bait achieved similar results with steady 90-95% average efficacy against both rodent species. As plate bait and grain bait were examined only in 2010, we are unable to assess whether these two formulations would be justified in practice or

not. At Stari Tamiš, low efficacy of commensal rodent control in 2009 caused the experiment to be repeated. After a detailed analysis we concluded that insufficient efficacy of sodium selenite had several main causes.

Table 1. Efficacy of different formulations of sodium selenite in controlling *Mus musculus* and *Rattus norvegicus*

Year Godina	Formulation Formulacija	Efficacy (%)-Efikasnost (%)	
		<i>Mus musculus</i>	<i>Rattus norvegicus</i>
2003	RB	100	100
2004	BB	87.5	88.1
	RB	100	92.5
	GB	95.3	91.3
2005*	BB	98.4	94.4
	RB	97.0	97.0
	GB	97.6	93.6
2006*	BB	-	87.5
	GB	100	92.5
2007	BB	98.4	87.5
	GB	97.6	91.1
2008	BB	88.9	86.4
	GB	100	95.0
2009	GB	81.1	81.1
2010*	GB	-	76.2
	PB	-	70.0
	AB	-	67.5
2011	GB	71.4	82.1

2005* (Vukša, 2005); 2006* (Vukša et al., 2006); 2010* (Dedović et al., 2011)

Manipulation of stored goods and products, content change in storage facilities, and human activities and extended human presence may reduce the activity of rodents. Certain microclimatic conditions, particularly increased temperature and humidity, may cause baits to develop mould, as well as toxins that repel rodents from consuming such bait. As sodium selenite is readily soluble in water (Anonymous, 2003), a fact that requires attention during bait laying, both the active ingredient and baits are prone to fast degradation. Also, the speed of metabolic processes has been proved to influence selenium degradation in an organism (Anonymous, 2003). Generally, the same causes can affect the efficacy of other active ingredients as well. Laboratory experiments have confirmed a high toxicity of sodium selenite to laboratory mice and rats (Jačević et al., 2011) but low acceptability and palatability of baits containing 0.1% of technical grade sodium selenite (Jokić, 2012). Based on ecotoxicological properties of sodium selenite (Anonymous, 2003), product contents and rates of application, we have concluded that treatment of rodent pests with sodium selenite indoors contributes to strengthening an environmentally safe strategy. The efficacy of sodium selenite baits corresponded with levels of effectiveness of chemical rodenticides (anticoagulants) that are used to control *Mus musculus* and *Rattus norvegicus* (Buckle and Smith, 1994).

CONCLUSION

Effective management of commensal rodents requires good knowledge of rodent species and their ecology, as well as a strategy for their control. The results of this investigation of efficacy in controlling two rodent species indicate good acceptability and high efficacy of all formulations, especially of granular bait (GB). Plate bait (PB) and grain bait (AB) demonstrated lower efficacy against *Rattus norvegicus*. An effective strategy should be developed for management of established ro-

dent populations and the use of rodenticides should be minimized in order to prevent negative consequences to the environment. The best results in rodent management can be achieved by treating surrounding farms and facilities, and conducting systematic deratization because individual treatments, such as mostly practiced in this country, fail to achieve desired results. New acute rodenticides that would act less invasively and avoid secondary poisoning of non-target organisms are not expected to be developed in the foreseeable future and this fact puts an additional weight to research of products based on selenium). These products can be recommended for use in organic and traditional production systems as both the available literature and our experimental results guarantee food safety without disturbing other elements of the food chain. They can be combined with other ecologically designed measures to improve technological solutions, i.e. the attractiveness of formulations to rodents.

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