

IPM STRATEGY FOR RODENT CONTROL IN STORAGE FACILITIES**

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Abstract: The fundamental idea of IPM is to put nature's own regulatory mechanisms to maximum use in order to prevent damage, which is in the best interest of manufacturers, society at large and the environment. However, *Haines* (2000) assessed stored products IPM still insufficiently developed at the end of the 20th century. Support to IPM development in stored agricultural products is the use of natural compounds to control rodent pests. One of such compounds is cellulose, whose mode of action differs from the modes of other rodenticide active ingredients.

As resistance to I and II generation anticoagulant rodenticides has been reported worldwide, we have introduced for the first time anywhere in the world a rodenticide based on Se (0.1% sodium selenite) with a mode of action based on the replacement of SH groups of functional enzymes with S-S groups. We also tested products based on vitamin D3 with a known mechanism of action.

The new Se-based products achieved good efficacy against rat (91.10 % and 87.50 %) and mouse (97.60% and 98.40%), and cellulose-based product against mouse (91.66%), compared to products based on vitamin D3 in rat (90.00% and 90.30%) and mouse control (98.60% and 98.2%), bromadiolone in rat (93.80% and 90.7%) and mouse control (92.86% and 91.9%) and brodifacoum in mouse control (97.06%).

The products based on Se, vitamin D3 and cellulose have good toxicological and ecological properties and the fact that there have been no known cases of resistance make them recommendable for use against rodents in storage facilities.

Key words: cellulose; selenium; storage facilities; biological efficacy

Introduction

Integrated pest management (IPM) is a complex approach to agricultural

operations involving, among other methods, the use of natural products to prevent damage. The system is designed to satisfy both manufacturing and environmental interests *Kogan (1998), Cumming (2006)*.

Several methods are currently available in agricultural storage facilities for controlling or reducing potential damage by rodents, but IPM programmes are still insufficiently developed *Haines (2000), Spragins (2006)*. Anticoagulant products have been used to protect stored agricultural products for many years now, but resistance to them, especially to first generation anti-coagulants and increasingly to bromadiolone, has been reported worldwide. A number of studies and publications have tackled this problem across the globe. The Rodent Resistance Action Committee (RRAC) has been set up to monitor the issue. Rodents are known to be able also to develop resistance to some newly-designed anticoagulants, as well as cross-resistance to old and new compounds *Lund (1984), Graves (1995), Myllymaki, (1995), Thijssen (1995)*.

We therefore tested products that contain active ingredients to which no resistance has been observed so far and which can be applied in cases of altered susceptibility to other rodenticides currently in use, while being environmentally safe and not causing secondary poisoning.

A rodenticide based on Se (0.1 % sodium selenite), with the mode of action based on replacement of the SH group of functional enzymes with the S-S groups, was tested.

Another such compound is cellulose, a naturally-occurring substance with a mode of action different from other rodenticide active ingredients. Ingestion of cellulose baits by mice leads to immediate dehydration, decrease in blood volume and blood pressure, tissue decay and circulation arrest, and the ultimate result is death *Anonymous (2005)*.

Materials And Methods

Six products manufactured by the company A.D. "Ciklonizacija", Novi Sad, Serbia, were tested against *Rattus rattus* and *Mus musculus* for biological efficacy: EKOSSEL-C(KH) granules (0.1% Na selenite); EKOSSEL-C(KH) paraffinized block (0.1% Na selenite); EKOSTOP-D3 granules (0.075% cholecalciferol); EKOSTOP-D3 paraffinized briquettes (0.075% cholecalciferol); MAMAK B (KH) granules (0.005% bromadiolone), and MAMAK B (KH) paraffinized block (0.005% bromadiolone).

Product efficacy was tested in the feed mixing facility of the Institute of

Animal Husbandry in Belgrade, the storage room of the Old People's Home "Bežanijska Kosa", Belgrade, and the warehouse of the Edible Oil Factory "Evit", Vrbas.

The feed mixing and storage room of the Institute of Animal Husbandry is a hall sized 20 x 30 m containing a feed mixing machine with accessory electrical wiring, and sacks of feed lifted up on palettes.

The storage room of the Old People's Home "Bežanijska Kosa" is sized 20 x 25 m with palettes supporting sacks with foodstuffs such as flour, potatoes, sugar, various vegetables, oil, etc. A unit for storage and preparation of meat and fish with a tiled sanitary block is included.

The warehouse of the Edible Oil Factory "Evit" in Vrbas is sized 15 x 70 m and contains rows of palettes with packed products.

Mus musculus was found in the Institute's feed mixer and storage facility, and *Rattus rattus* in the storage room of the Old People's Home and warehouse of the Edible Oil Factory.

The trial testing Natromouse was carried out in warehouses the Belgrade Institute of Animal Husbandry where agricultural products (sunflower, maize, wheat and feeding meal) are stored in sacks and lifted up on pallets, rather than being kept as bulk goods. Total surface area treated with the test products was 1,600 m². *Mus musculus* was found in the warehouses.

Natromouse, manufactured by PINUS TKI d.d., Rača, Slovenia, was tested for its biological efficacy. It is a natural product composed of powdered maize cobs (40-45% cellulose).

A bromadiolone-based product (Brodisan-PEF, manufactured by EKO-SAN, Belgrade) and another one based on brodifacoum (Rattack – paraffinized pellets, manufactured by DUOHEM, Belgrade), both containing 0.005% a.i., were used as standards.

The trial complied with the PP 1/114(2) method (OEPP/EPPO, 1999). Rodent abundance was assessed using the C-30 method (World Health Organization) or the transect method (EPPO, 1990) at the beginning and 10 days after the beginning of trial. Placebo bait was laid at 10 spots in each facility over a period of 5 days.

Test baits were laid on plates in portions of 15-25 g for mice and 80-100 g for rats at 2-4 m intervals directly into active holes where rodent activity or damage had been observed previously, around electrical wiring and along rodent paths (underneath palettes).

Data on palatability and biological effectiveness of products under laboratory conditions and rodenticide efficacy against rodents in storage facilities were calculated using *Abbott's* formula (1925).

Results

Table 1 shows the efficacy of the Se-based products EKOSEL-C(KH) granule and EKOSEL-C(KH) paraffinized block; cholecalciferol-based products (vitamin D3) EKOSTOP-D3 granule and EKOSTOP-D3 paraffinized briquettes; and bromadiolone-based products MAMAK B (KH) granule and MAMAK B (KH) paraffinized block, all applied against *Mus musculus* and *Rattus rattus* in storage facilities.

The results show a very good efficacy of the Se-based products in controlling rat (91.10% and 87.50%) and mouse (97.60% and 98.40%), compared to products based on vitamin D3 (93.00% and 90.30% against rats; 98.60% and 98.20% against mice) and bromadiolone (93.8% and 90.7% against rats; 92.86% and 91.9% against mice).

Table 1. Rodent abundance and rodenticide efficacy

Product	Species	Abundance		Efficacy (%)
		Beginning	End	
MAMAK B (KH) granules	<i>R. rattus</i>	32	2	93,80
	<i>M. musculus</i>	14	1	92,86
MAMAK B (KH) paraffinized block	<i>R. rattus</i>	43	4	90,70
	<i>M. musculus</i>	11	2	97,20
EKOSTOP-D3 granules	<i>R. rattus</i>	57	4	93,00
	<i>M. musculus</i>	10	1	98,60
EKOSTOP-D3 paraff. briquettes	<i>R. rattus</i>	52	5	90,30
	<i>M. musculus</i>	7	1	98,20
EKOSEL-C granule	<i>R. rattus</i>	45	4	91,10
	<i>M. musculus</i>	14	2	97,60
EKOSEL-C paraffinized. block	<i>R. rattus</i>	48	6	87,50
	<i>M. musculus</i>	11	1	98,40

No data are available in literature on Se being used as a rodenticide. However, this investigation shows that very good efficacy of such products can be achieved. Our results in efficacy testing of cholecalciferol (vitamin D3) and bromadiolone products against *Mus musculus* and *Rattus rattus* are consistent with reports by other authors Row. *et al.*(1981); Parshad *et*

al.(1987); *Brooks and Rowe* (1987); *Quy, R.J.; Milić*(1999);*Vukša et al.*(2002).

Selenium is an active substance used in human and veterinary medicine as a vitamin and, in its biologically active form, it is a micronutrient important for immune responses. However, as doses much higher than the recommended therapeutical ones are proposed here, and data on acute toxicity, toxicology and ecotoxicology support it *Anonymous* (1993), sodium selenite as an active ingredient has been classified into poison group II in Serbia and approved to be used as a rodenticide. Se-based products have been classified into poison group III as concentrations of sodium selenite in them is no more than 0.10%.

Table 2 shows the efficacy of the Natromuse product based on cellulose as a natural active ingredient, brodifacoum-based Brodisan PEF, and bromadiolone-based Rattak paraffinized pellet.

Table 2. Efficacy of test products in controlling house mouse (*Mus musculus*) in agricultural storage facilities

Product	Concentration of active ingredient	Abundance		Efficacy (%)
		Begining	End	
Natromuse	45.00 % (<i>Cellulose</i>)	36	3	91.66
Brodisan PEF	0.005 % (<i>Bromadiolone</i>)	29	4	86.20
Rattack-p.par.	0.005 % (<i>Brodifacoum</i>)	34	1	97.06

Our results show that the cellulose product had 91.66% efficacy in controlling house mouse (*Mus musculus*) in agricultural storage facilities. The bromadiolone product had 86.20% efficacy and brodifacoum 97.05%.

No other data are available on the efficacy of cellulose-based products in controlling rodent pests. According to a report by *Brooks and Rowe* (1987), published by the World Health Organization, the efficacy of bromadiolone products (0.005% a.i.) applied in the field to control house mouse (*Mus musculus*) ranged from 70% to 100%. Brodifacoum products (0.005% a.m.) were shown to have efficacy ranging from 98.4% to 100%.

Products based on bromadiolone and brodifacoum have been found to demonstrate 80.8-97% efficacy against house mouse on poultry farms *Parshad et a.l* (1987), *Shafiet al.*. (1992).

Rowe et al. (1978) reported a brodifacoum efficacy against house mice on farms as ranging between 92.7% and 100% (mean 98.8%). Bromadiolone

efficacy against the same farm pest ranged from 92.7% to 100% (mean 92.4%) in another trial *Rowe et al.*(1981).

Conclusion

Good efficacy, favourable ecological properties and the fact that there have been no known cases of resistance make Se-based products recommendable for use to control rodents in storage facilities.

Compared to brodifacoum and bromadiolone efficacy, cellulose, as a natural active ingredient, was found to have satisfactory efficacy in controlling house mouse in agricultural storage facilities.

IPM STRATEGIJA ZAŠTITE USKLADIŠTENIH POLJOPRIVREDNIH PROIZVODA OD GLODARA

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Rezime

Osnovni smisao IZB je maksimalna iskorišćenost prirodne regulacije u prevenciji i sprečavanju nastanka šteta, što je u interesu proizvođača, društva i životne sredine. Prema *Haines-u* (2000), na kraju dvadesetog veka, IZB još uvek nije bila dovoljno razvijena u skladištima poljoprivrednih proizvoda. Podrška razvoja IZB je i upotreba prirodnih jedinjenja za suzbijanje štetnih vrsta glodara. Jedno od njih je i celuloza, sa mehanizmom delovanja različitim u odnosu na druge rodenticidne aktivne materije.

Zbog zapažene pojave rezistentnosti na rodenticide na bazi antikoagulanata I i II generacije uvedeni su, po prvi put u svetu, u primenu i preparati na bazi Se (0,1 % natrijum selenita) čiji je mehanizam delovanja zasnovan na zameni SH grupa funkcionalnih enzima S-S grupama. Takođe, smo primenili preparate na bazi vitamina D3 sa poznatim mehanizmom delovanja.

Ispoljena je veoma dobra efikasnost novog preparata na bazi Se u suzbijanju pacova (91,10 % i 87,5%) i miševa (97,60% and 98,40%) i na bazi celuloze u suzbijanju miševa (91,66%) u poređenju sa preparatima na bazi vitamina D3 u suzbijanju pacova (90,00% and 90.30 %), i miševa

(98,60% and 98,2%), bromadiolona u suzbijanju pacova (93,8% i 90,7%) i miševa (92,86% i 91,9%) i brodifakuma u kontroli miševa (97,06%).

Zbog dobre efikasnosti, povoljnih ekoloških svojstava i nepostojanja rezistentnosti preparate na bazi Se bi trebalo što više koristiti u suzbijanju glodara u skladištima.

Ključne reči: celuloza; selen; skladišta poljoprivrednih proizvoda; biološka efikasnost

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