

# Efficacy and Palatability of Different Rodenticide Formulations Applied against House Mouse (*Mus musculus* L.) in Plant Storage Facilities

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## SUMMARY

Palatability (daily intake) of different rodenticide formulations based on bromadiolone was compared in experiments with house mouse (*Mus musculus* L.) in agricultural storage facilities, and rodent numbers were assessed at the beginning and end of experiment, as well as rodenticide efficacy. The dynamic of bait intake was monitored for ten days in facilities of the Institute of Animal Husbandry in Zemun and the Agricultural Cooperatives at Starčevo and Omoljica.

The experiments complied with the relevant standard method of OEPP/EPPO. Agricultural products were stored either as bulk commodities or in sacs laid on pallet racks in the treated facilities. Baits were laid in boxes on mice routes below pallets holding sacs and on places where significant damage had been observed, at 1-3 m spacing and in 10-20 g portions. Mouse abundance was estimated based on the highest and lowest daily intakes of bait by mice over a period of 10 days, which was divided by the mouse daily feed requirement. The presence of house mouse was also monitored over the next 20 days. The efficacy of test products was computed using Abbott's formula.

**Keywords:** Bromadiolone; *Mus musculus* L.; Efficacy; Palatability

## INTRODUCTION

House mouse (*Mus musculus* L.) is a widespread species across the world, except in the northeastern and eastern parts of Asia and northern Canada. Besides brown rat (*Rattus norvegicus*) and black rat (*Rattus rattus*), house mouse is the next most significant mammal pest of stored products (Drummond, 2001; Đukić

et al., 2005). It breeds fast and tends to overpopulate. It produces up to four litters a year, each with 5-12 young. It reaches sexual maturity at the age of two months and actively breeds when 70-75 days old. In natural environments, it normally lives 1-1.5 years (Ružić, 1983; Đukić et al., 2005). It nests in places that are close to food sources, among sacs, in various cracks and crevices and in other hidden places.

Daily food requirement of a house mouse is equivalent to 15% of its weight (3–4 g), totalling up to 1.4 kg a year (Gwinner et al., 1996). It normally visits a food source close to its nest between 20 and 30 times during the night. It causes considerable damage both by feeding and by polluting and damaging a variety of products of plant, animal or synthetic origin (Ružić, 1983; Gwinner et al., 1996). According to Hrgović et al. (1991), a house mouse may pollute as much as nine times more food than it able to eat. Measures to control house mouse in agricultural storage facilities are therefore taken immediately after its presence has been observed (Spragins, 2006).

Besides some advisable preventive measures, taken either at the time of construction of a facility or during storage of agricultural commodities, chemical control is the most widely practiced form of suppression of harmful rodents (Endepols, 2002; Sayed and Lynwood, 2002). The mean lethal dose (LD<sub>50</sub>) of bromadiolone for mice is 1.75 g/kg (Tomlin, 2006). Depending on an intake of bromadiolone bait and susceptibility of a population, mortality will occur as of day four (Gorham, 1991). According to Prakash et al. (2003), the most important properties of rodenticide baits are palatability, toxicity and speed of action.

Palatability of baits primarily depends on bait characteristics (formulation, colour, outlook, odour), but also on rodent behaviour and availability of other food sources (amount and quality of food). It is especially important when alternative sources of quality food are

readily available (Parshad and Malhi, 1995; Kaur and Parshad, 2005).

In this study, the objective was to determine the efficacy of different formulations of bromadiolone-based rodenticides in controlling house mice under conditions of high availability of alternative food sources. Also, we wanted to compare the appeal of baits (daily intakes) in plant commodity storages.

## MATERIAL AND METHODS

The experiments were conducted in storage facilities for plant commodities of the Institute of Animal Husbandry in Zemun and the Agricultural Cooperatives at Starčevo and Omoljica in 2005 and 2007. Agricultural products (wheat, maize, soybean and sunflower coarse meal) were stored in the treated facilities as bulk commodities or packed in sacs and stored on pallet racks. Mice presence was determined based on their faeces, traces of movement and damage to stored products.

The experiments were conducted in compliance with the OEPP/EPPO method (1999a). Three different rodenticide formulations, each containing 0.005 g/kg bromadiolone active ingredient, were applied.

The rodenticide trade names, manufacturers and formulations are given in Table 1.

Poisonous baits were laid in boxes on expected mice routes underneath pallets with sacs and in places where most damage had been observed. They were laid in

**Tabela 1.** Rodenticides applied

**Table 1.** Upotrebljeni rodenticidi

Product* – Preparat*	Manufacturer – Proizvođač	Formulation – Formulacija
Gardentop	ZAPI Industrie Chimiche S.p.A., Italy / Italija	Bait ready for use (RB) Gotovi mamci za upotrebu
Brodilon meki mamac	Veterina, Kalinovica, Croatia / Hrvatska	Bait ready for use (RB) Gotovi mamci za upotrebu
Ratibrom 2 esca fresca	Kollant s.p.a., Milano, Italy / Italija	Bait ready for use (RB) Gotovi mamci za upotrebu
Ratibrom 2 grain	Kollant s.p.a., Milano, Italy / Italija	Grain bait (AB) Zrnasti mamak
Hemus AB	Hemovet, Vršac, Serbia / Srbija	Grain bait (AB) Zrnasti mamak
Ratibrom 2 pellets	Kollant s.p.a., Milano, Italy / Italija	Plate bait (PB) Peletizirani mamak
Brodisan PEF	Ekosan d.o.o., Beograd, Serbia / Srbija	Plate bait (PB) Peletizirani mamak

\* Each product contains 0.005 g/kg bromadiolone

\*Svaki preparat sadrži 0,005 g/kg bromadiolona

portions of 10-20 g at 1-3 m spacing. Over 10 days of monitoring, daily bait intake was recorded and portions replenished. Nontoxic placebo baits were first laid in identical boxes four days before the beginning of experiment. The abundance of house mouse was estimated based on the highest and lowest daily bait intake divided by the daily feed requirement. Mice presence was monitored over the following 20 days. The efficacy of the products tested was computed according to Abbott's formula (Abbott, 1925).

## RESULTS AND DISCUSSION

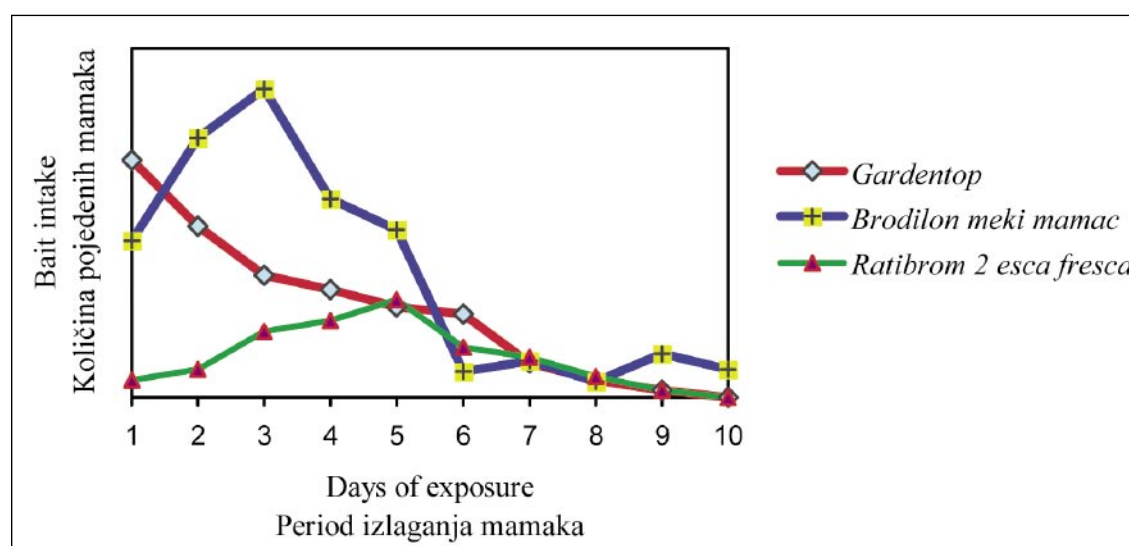
Table 2 shows total rodenticide bait intakes, maximum placebo bait intakes in the four days of exposure, and estimated numbers of rodents at the beginning and end of experiment.

Figures 1, 2 and 3 show the appeal that poisonous baits had to mice depending on their formulation during the ten-day experiment.

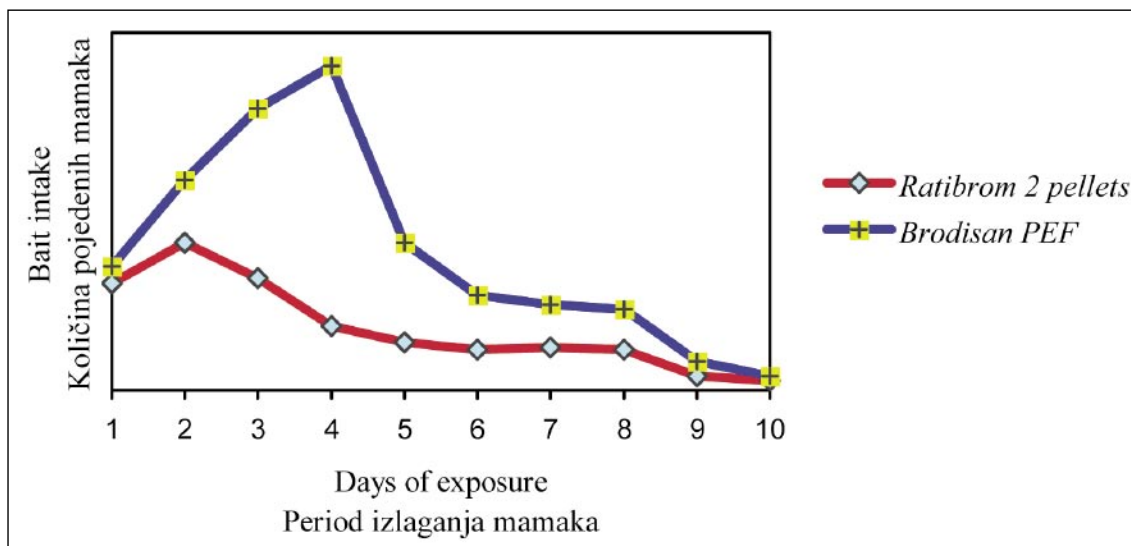
Figure 1 presents the palatability of the ready to use baits (RB formulations). The products are pastes packed in bags of 10 g each.

**Tabela 2.** Rodenticides applied  
**Table 2.** Upotrebljeni rodenticidi

Product Preparat	$\Sigma$ Placebo bait intake pojedenih placebo mamaka (g)	$\Sigma$ Poisonous bait intake pojedenih otrovnih mamaka (g)	Max. total placebo bait intake/day Max. količina pojedenih placebo mamaka/dan (g)	Estimated rodent numbers Procenjena brojnost glodara	
				Beginning Na početku	End Na kraju
Gardentop	445	250	150	25	1
Brodilon meki mamac	785	356	220	37	4
Ratibrom 2 esca fresca	250	116	70	12	1
Ratibrom 2 grano	160	66,5	47	8	1
Hemus AB	160	86,5	55	9	1
Ratibrom 2 pellets	268	131,5	77	13	2
Brodisan PEF	492	292	170	29	4



**Figure 1.** Palatability of ready to use baits (RB formulationa)  
**Slika 1.** Atraktivnost testiranih gotovih mamaka (RB formulacije)



**Figure 2.** Palatability of plate baits (PB formulation)

**Slika 2.** Atraktivnost testiranih peletiziranih mamaka (PB formulacije)

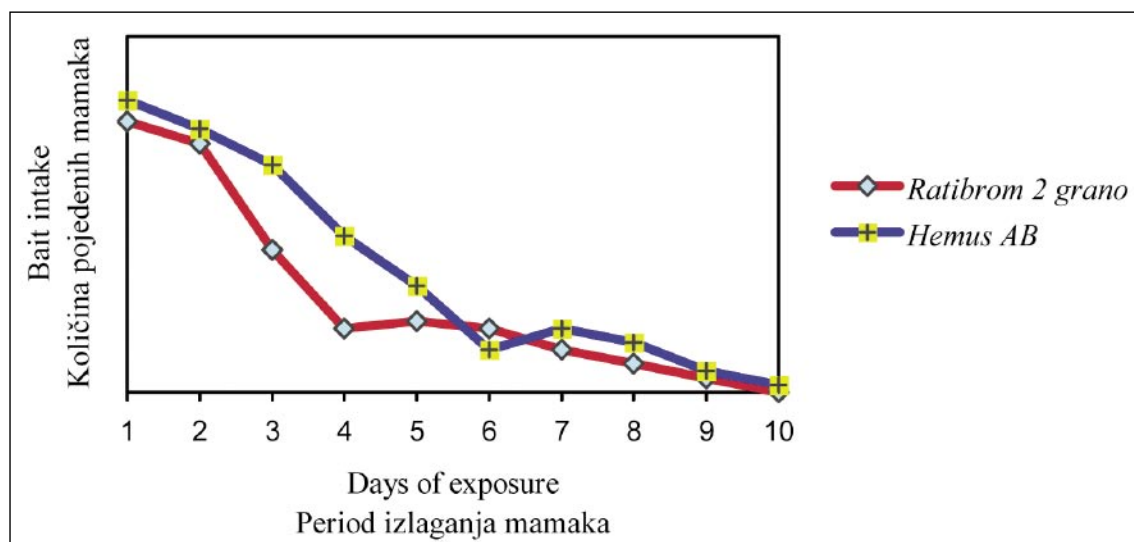
The RB rodenticide formulations tested were found to differ regarding palatability. Brodilon meki mamac was consumed most intensively on the third day of experiment, while the palatability of Ratibrom 2 esca fresca increased, reaching a peak on the fifth day. The appeal of the product Gardentop was highest on the first day and decreased gradually towards the end of experiment.

Figure 2 shows palatability of plate baits (PB formulation).

Palatability of the plate baits tested increased from the beginning of the experiment, and reached the highest value on the second (Ratibrom 2 pellets) and fourth day (Brodisan PEF).

Figure 3 presents the palatability of grain baits (AB formulation), i.e. baits consisting of active matter applied to bulk grains.

Palatability of the grain baits tested was highest at the beginning of the experiment and extended toward



**Figure 3.** Palatability of grain baits (AB formulation)

**Slika 3.** Atraktivnost testiranih zrnastih mamaka (AB formulacije)

ds its end. Figure 3 shows approximately the same curves for grain bait palatability.

A number of authors (Parshad and Malhi, 1995; Inglis et al., 1996; Prakash et al., 2003; Johnston et al., 2005) refer to the importance of bait appeal to rodent pests for their successful control. The OEPP/EPP (1999b) method describes laboratory tests of bait palatability. However, we were unable to find any reference in domestic or foreign literature to investigations of bait palatability under „field conditions“, i.e. in agricultural storage facilities. Specificities of the protection of agricultural stored products caused by poor structural construction, frequent product manipulation, level of noise caused by various machinery, etc. have led us to a conclusion that successful pest control requires fast consumption of poisonous baits, i.e. high palatability, apart from other factors.

Data on the efficacies of test rodenticides are shown in Figure 4.

Efficacy of the rodenticides tested ranged between 84% for the product Ratibrom 2 pellets and 96% for Gardetop. Overall, the RB formulations demonstrated higher efficacy than plate and grain baits. Also, considering the application method and safety, RB formulations are safer products for house mice control in agricultural storage facilities, especially for bulk commodities. All products tested were found to have satisfactory efficacy when alternative food sources were available.

According to data quoted by Brooks and Rowe (1987) collected by the World Health Organization, the effi-

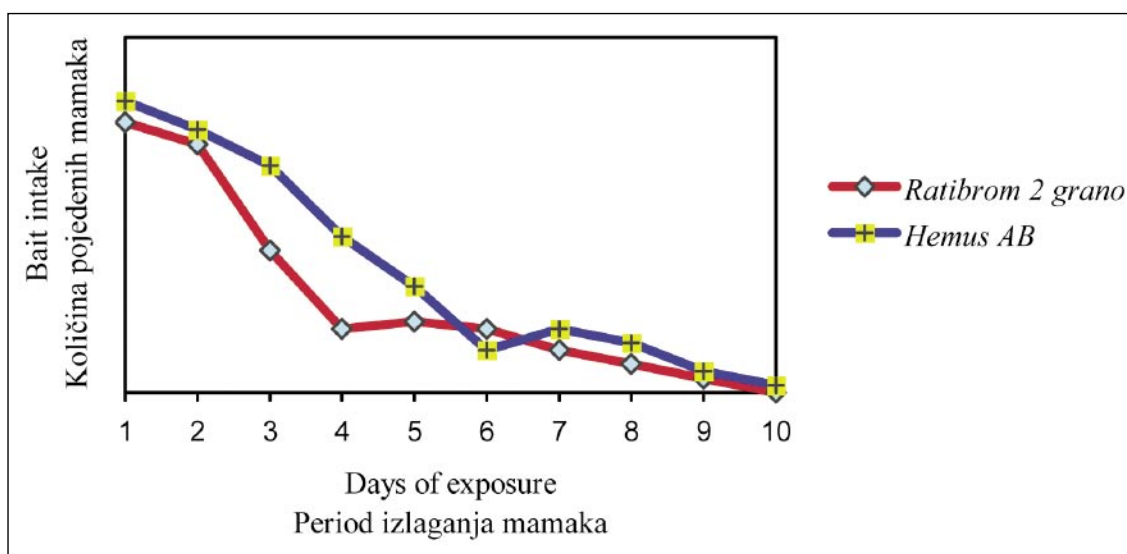
cacy of products based on bromadiolone for the control of house mouse outdoors and indoors ranges from 75% to 100%. In a study conducted by Advani (1995), the efficacy of plate baits against house mouse in urban environments was lower (89%) than the efficacy of ready to use baits (94%). Vukša et al. (2006) recorded a 93% efficacy of grain baits and 97% efficacy of paraffinized blocks in experiments conducted in agricultural storage. In a research of the efficacy of bromadiolone-based products on farms, Rowe et al. (1981) registered 92-100% efficacy.

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**Figure 4.** Efficacy of rodenticides tested in agricultural storage facilities  
**Slika 4.** Efikasnost testiranih rodenticida u skladištima poljoprivrednih proizvoda

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# Efikasnost i atraktivnost različitih formulacija rodenticida u suzbijanju domaćeg miša (*Mus musculus* L.) u skladištima biljnih proizvoda

## REZIME

Upoređena je atraktivnost (dnevna prihvatljivost) različitih formulacija rodenticida na bazi bromadiolona u eksperimentima sa domaćim mišem (*Mus musculus* L.) u skladištima poljoprivrednih proizvoda, procenjena brojnost glodara (na početku i kraju eksperimenta) i efikasnost rodenticida. Desetodnevno praćenje dinamike konzumiranja mamaka obavljeno je u objektima Instituta za stočarstvo u Zemunu i poljoprivrednim zadrugama u Starčevu i Omoljici.

Eksperimenti su izvedeni prema standardnoj metodi OEPP/EPPO. U tretiranim objektima poljoprivredni proizvodi su se nalazili u rasutom stanju i u vrećama smeštenim na paletama. Mamci su postavljeni u kutije, na putevima kretanja miševa, ispod paleta sa vrećama i na mestima gde su primećena najveća oštećenja, na rastojanju 1-3 m i u količini od 10-20 g. Brojnost domaćeg miša je procenjena na osnovu najveće i najmanje dnevno pojedene količine mamka tokom 10 dana, podeljene sa njegovom dnevnom potrebom za hranom. Prisustvo domaćeg miša je praćeno i narednih 20 dana. Efikasnost testiranih preparata izračunata je prema Abbottovoj formuli.

**Ključne reči:** Bromadiolon; *Mus musculus* L.; efikasnost; atraktivnost