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Review

RODENT PEST CONTROL

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Abstract

Background. Rodent pests are natural reservoirs and vectors of a vast array of human and animal diseases caused by bacteria, rickettsia, viruses, protozoans, fungi and some parasites. The most important risk factor for human infection with *Trichinella* is the rearing of pigs on small farms and by rural households, if rodent pest control is not conducted regularly. Rodent pests cause economic losses by consuming, contaminating and/or damaging foods intended for human or animal consumption.

Scope and Approach. The aim of this work is to point out the epidemiological and epizootiological importance of regular rodent control, and the importance of integrated use of all measures in deratization, as well as mistakes which can be made in implementing this procedure.

Key Findings and Conclusions. The control of populations of pest synanthropic and hemisynanthropic rodents is a very complex and delicate task to carry out. Given all characteristics of the majority of rodent pest species, e.g. high reproductive potential, extraordinary adaptation to life in a variety of habitats and ability to develop resistance to anticoagulant rodenticides, the issue of controlling the number of rodent pests is considerably more problematic than it might seem at first glance. Therefore, appropriate scientific and professional knowledge is necessary to accomplish effective rodent

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control, which if done improperly, can have far-reaching negative consequences for human populations, non-target species and workers performing the task.

Key Words: anticoagulant, deratization, vector

INTRODUCTION

Mouse-like rodents are considered harmful for several reasons. Their activities result in economic losses due to their consumption, contamination and/or damage of foods intended for people and domestic animals. Besides the amount of a particular foodstuff they can ingest, rodents can additionally contaminate, in the form of excrement and shed hair, up to nine-fold greater amounts of the foodstuff. Rodent pests damage and destroy raw materials and products (Mushtaq and Khanam, 2017). The presence of these rodents is of epidemiological/epizootiological importance, since they are not only natural reservoirs but also transmitters of a broad array of causative agents of diseases in humans and animals, i.e., pathogenic bacteria, rickettsia, viruses, protozoans, fungi, helminths and other parasites (Bijelić-Čabrilo et al., 2013; Kataranovski et al., 2011; Hornok et al., 2015; Rabiee et al., 2018; Backhans and Fellstrom, 2012). These negative effects of rodents render their population control indispensable.

Control and eradication of populations of harmful synanthropic and hemisynanthropic rodents is an extremely difficult and delicate task. Thus, rodent control conducted in an unprofessional manner can have profound negative impacts for human populations, non-target species and for workers who are involved in the procedure. Having this in mind, appropriate theoretical and practical scientific and professional knowledge is necessary to plan and conduct rodent control (Krajcar 2008; 2011). Successful eradication of rodent pest species populations is inconceivable without good knowledge of their biological traits. It is of the utmost importance to know the lifestyle of the particular target species and their morphological and physiological characteristics, dietary habits and reproduction.

Enormous efforts have been made worldwide to invent novel and effective methods or chemical compounds intended to achieve better results in the control of mouse-like rodent populations. One of the most promising methods was thought to be limiting their rate of reproduction. Although chemosterilants (synthetic hormones) proved to exert negative effects on reproduction, as was confirmed in both male and female rats, news which was met with enthusiasm (Marsh and Howard, 1970, 1973; Ericsson, 1970, 1982; Gao and Short, 1993), no such substances remain in current use. The professional community withdrew their use of chemosterilants in spite of the fact that they are one of the most environment-friendly rodent control methods. It seems there is no prospect of implementing any methods for controlling the fertility of rodent pests more widely in practice.

The aim of the present work is to highlight the epidemiological/epizootiological and economic importance of regular rodent pest control, the importance of integrated

deployment of all measures and methods in rodent control, and the most frequent mistakes that occur when performing this task.

Epizootiological - epidemiological reasons for rodent control

Living in livestock facilities, in human residences and outside areas inhabited by people, pest rodents, especially rats and mice, can act as transmitters of a wide array of infective agents that cause diseases affecting humans, livestock and wild animals. The causative agents of infections are shed in faeces and urine and can contaminate water and foodstuffs. In some infections, fleas, ticks and mosquitoes transmit the pathogens from rodents to people and domestic animals. Pest rodents can transmit some infections both mechanically and by biting their prey (Meerburg et al., 2009).

Bacterial diseases, some of which are of the utmost importance, that are transmissible by rodents to humans and animals are tularaemia, brucellosis, leptospirosis, salmonellosis, tuberculosis, plague and pasteurellosis. Diseases caused by rickettsia and viruses which are transmissible by rodents are foot-and-mouth disease, haemorrhagic fever, rabies, spotted fever, typhoid fever, Aujeszky's disease and tick-borne encephalitis (Milagres et al., 2013; Heuser et al., 2017). Rats and mice are transmitters of various helminths (roundworms and tapeworms) and protozoans to humans and animals (Ondrikova and Stanko, 2009; Kataranovski et al., 2011; Backhans and Fellstrom, 2012; Bijelić-Čabrilo et al., 2013; CDC, 2017). Webster and Macdonald (1995) found that each of 510 brown rats live-trapped on eleven UK farms tested positive for, simultaneously, two to nine potentially zoonotic parasites. It is widely known that *Rattus norvegicus* and *Rattus rattus* play an important role in the spread of trichinellosis. The most prominent risk factor for human trichinella infection is the rearing of pigs on small farms or by rural households, if rodent control is not conducted regularly (Despotović et al., 2013). *Trichinella* infection is more frequent among *R. norvegicus* than among pigs, dogs and cats. Stojcevic et al. (2004) revealed that rats were infected only on farms with *T. spiralis*-positive pigs and with inadequate (or formerly inadequate) sanitation, but no infected rats were detected on farms with *T. spiralis*-negative pigs.

Economic reasons for rodent control

Besides these epidemiological/epizootiological reasons, rodent control is necessary due to the enormous economic losses resulting from some mouse-like rodents, which feed on, and contaminate with faeces, urine and hair, stored foods of plant or animal origins. Rodent pests damage material goods and inflict damage in textile, fashion and other industries, in agricultural lands, in abattoirs, in facilities for rearing domestic animals and in civil engineering (Rustamani et al., 2005; Awan and Hussain, 2015). The damage is most frequently caused by the brown, or Norway rat (*R. norvegicus*), the house mouse (*Mus musculus*) or the black rat (*R. rattus*), but the culprits can also be some of the other species of synanthropic and hemisynanthropic rodents. Damage to stored products is mainly caused by commensal rodent species (Almeida et al., 2013; Mushtaq

and Khanam, 2017). It is almost impossible to assess and precisely evaluate all the damage made by rodents. Nevertheless, according to the World Health Organization, as much as about 3 million tons of food (5% of total global food production) is destroyed by rodent pests annually. Food destroyed by rodents could be sufficient to feed 200 million people (Fredericks and Henriksen, 2012).

Methods of rodent pest control

Having considered the epizootical, epidemiological and economic importance of rodent pests, clearly, rodent control is inevitable. Given the traits of the majority of rodent pests, such as their high reproductive potential, special ability to adapt to living in various habitats and ability to develop resistance to some rodenticides belonging to first-generation anticoagulants, the issue of rodent control is considerably more complex than it may seem at first glance (Rylnikov, 2008; Sayer, 2017).

In practice, control of rats, mice and mouse-like rodents employs the same means and deployed methods, as the principles of control are identical for all target species. Rylnikov (2008) claims successful rodent control must be widespread:

- rodent control must be conducted simultaneously in large and connected areas,
- rodent control must be conducted simultaneously on all public surfaces, buildings and sewage systems in the area.

To ensure rodent control is successful, only integrated deployment of preventive, mechanical, physical and chemical methods will lead to the desired results. Unfortunately, in practice today, largely, only chemical measures are used, so rodent control is often equated with exposure to toxic baits, which is a considerable misunderstanding (Krajcar 2002; 2011).

Preventive measures

Although preventive measures are not intended for direct suppression of rodent pests, these are of great importance in combating rodents and should be deployed as part of the complex process of rodent control. When planning and conducting rodent control, it is necessary to devote assiduous attention to preventive measures. The aim of prevention is to block the entrance, settling, feeding, and survival of harmful rodent species in closed areas, using technical and hygienic means. Multiple forms of preventive measures are at our disposal.

a) **Technological and manipulative measures** – These measures involve appropriate placement and manipulation of raw materials, partially finished goods and finished products in supply stores, storehouses, granaries, barns and other rooms/buildings where rodent pests occur. Stored foodstuffs, raw materials and goods must be placed to enable visual control over them, without dead observation spots in the corners. Before import into the area, each bulk lot must be thoroughly inspected to prevent rodents ingressing the premises *via* the incoming materials. The presence of rodents

can be detected using blacklight: rodent urine shows blue-white to yellow-white fluorescence when exposed to ultraviolet light. This is caused by amino acids in rodent urine and hair. This rodent detection technique is most effective when inspecting packages, stored materials and goods packed in sacks (Kolbe, 2016).

b) **Architectural-technical measures** – When considering rodent pest prevention, an important impact is exerted by the architectural and technical characteristics of the given buildings, i.e., the materials from which they are constructed, their layout, design, and construction (Acheta, 2018). Buildings should prevent intrusion of pests and minimize the establishment and reproduction of any which do finally succeed in entering. Irrespective of the type and purpose of the building, these measures include the following:

1. Building all foundations and floors from solid, high-quality materials.
2. Closing all openings around conduits for electrical, water and gas supply networks.
3. Installing doors with door jambs made of metal.
4. Placing protective mesh on windows.
5. Placing protective mesh on ventilation and other apertures.
6. Building barriers in sewer systems, and placing grates on gutters and drains.
7. Erecting fences around the facilities, with foundations made of solid material.

c) **Sanitary and hygienic measures** – Strict sanitary measures involve cleaning and maintaining hygienic conditions on a daily basis. They are important and effective in combating rodent pests. The choice of sanitary measures depends on building construction and use. Appropriate sanitary measures are all based on creating unfavourable conditions for the continued existence of rodent pests in facilities and their vicinity. For example, appropriate order of goods must be maintained in the external yard, stored foods/products must be placed and manipulated to avoid spillage, rooms and food containers must be regularly washed, and waste must be regularly and appropriately disposed of. These measures play an important role in organized rodent control because they diminish the animals' food choices, thus rendering rodent baits acceptable. Rylnikov (2008) concluded that rodent control is less successful in spring and summer than in autumn or winter. The reason, he presumes, is the abundance of available food in warmer months, making rodent baits less attractive.

d) **Repellents –** Repellent substances are applied on surfaces, and are mainly chemical synthetic compounds that deter the target rodent pest from approaching due to their smell or taste. The following repellents are relatively effective: oil obtained from oil shale, albihtol and zinc salt of dimethyldithiocarbamic acid, which is widely utilized (Videc, 2006). The latter is used for dusting rodent holes and rodent runways where the animals regularly circulate. The repellent effect of zinc salt of dimethyldithiocarbamic acid is based on its irritating effects on nasal and oral mucous membranes. Repellents can be added and mixed into various construction materials (they are added to sand, cement, polyethylene and some other raw materials). Many plant species with intense odour can act as repellents and can protect crops. Dubey et al. (2011) extensively

reviewed plant-derived substances with potential deterrent effects on rodents. In laboratory conditions, eucalyptus (Kalandakanond-Thongsong et al., 2010; Singla et al., 2014), peppermint, bergamot, wintergreen, geranium and chilli oils are effective repellents against rats (Kalandakanond-Thongsong et al., 2010).

2. Mechanical methods

Mechanical means of rodent control can be used in limited areas or premises with low infestation rates. These are also useful when it is necessary to estimate the number of rodent pests before and after control is conducted using chemical substances. Satisfactory rodent control cannot be achieved by using exclusively mechanical methods, although these have an advantage over other methods because they do not harm the environment, people, domestic animals or non-target species. They are useful when rodent exclusion is the target and if a small number of pests has to be exterminated.

a) Obstacles – Obstacles are positioned to exclude rodents. To prevent pests from gaining entry, mesh is used to seal window and door openings. Mesh must be made of materials that rodents cannot gnaw, preferably steel, with apertures not larger than 6 mm in diameter.

b) Traps – Rodent traps are equipped with a mechanism including a spring which closes the trap (live mouse/rat traps) or kills the entrapped pest by hitting it (kill traps). A common feature of traps, regardless of whether they catch live or dead animals, is that fresh and attractive baits are necessary to render them functional. Baits must be compatible with the environment and placed near the rodent runways or in places where they spend considerable time. Snap traps are placed along walls, with the mechanism which snaps turned to the wall. If positioned far away from walls, they are ineffective (Weihong et al., 1999). The traps should be exposed for several days without baits and with the entrapping mechanism blocked, to ensure the rodents become accustomed to them. Ideally, traps should be manipulated using gloves, to prevent rodents from scenting humans. However, it is far more important to clean and wash the traps after use so they do not smell of previous use, since rodents are more readily deterred by the scent of another of their kind than of humans. Rodent pests very quickly detect and recognize threats and successfully avoid them. Thus, it is important to place as many traps as possible to ensure successful rodent control. Rodent traps are more frequently used when small numbers of pests are to be exterminated, in abattoirs and milk-processing facilities. They are also used in field investigations when monitoring rodent species abundance and rodent populations, and/or zoonotic infections in a given area (Krajcar, 2002).

c) Glue – Special glues with strong adhesive capabilities and prolonged drying times can be spread on hard surfaces (cardboard, glass, plastic or tin) to trap rodents. Glues are also available as commercial sticky traps and glue boards. They are placed in rodent runways so the animals cannot avoid the glue traps by bypassing them. Although

considered inhumane, this mean of combatting mouse-like rodents is used in catering/tourism industries, education facilities, residences, offices, etc.

3. Physical methods

Physical methods to combat rodents include approaches which utilize sound and light to repel or prevent pests from entering and/or residing in the area.

a) Use of ultrasound and electromagnetic waves – Despite the common misconception that rodents can be successfully deterred with ultrasound, based on the fact that they are sensitive to long wavelengths, ultrasound waves do not considerably influence their behaviour (Smith and Meyer, 2016). These short wavelengths do not penetrate solid barriers but are absorbed by many surfaces, which is why the rodents hiding in their shelters are practically protected. Even commercially available devices that produce electromagnetic waves were ineffective due to the inappropriate wavelength. In addition, these devices can make sensitive people feel uncomfortable (Wieringen and Glorieux, 2018).

b) Use of noise-producing devices – To prevent rodents from entering or residing in the area, repellent noise-producing devices can be used. These emit specific continuous or intermittent audible wavelengths at frequencies which are irritable to rodents, or emit sounds which mimic predatory birds. However, rodents can rapidly become accustomed to these and discover that there is no real danger, so the frequencies of the emitted sounds must be changed regularly to maintain any deterrent effect.

c) Use of light – Mice and rats are nocturnal animals, and their activities usually begin at twilight only when their population is extremely dense. However, leaving the light turned on in the area is ineffective. It is better to avoid clutter, prevent shade, make corners of the room visible for observation and remove objects which rodents can use as shelter.

4. Chemical methods

The use of rodenticide chemicals is, for now, the most rapid and effective means of suppressing overgrowing populations of pest rodents, which is why in practice the term deratization is frequently identified with only the use of poison-containing baits to control these animals. Rodenticides have an advantage over other means of rodent control as they can be used over wide areas (in large cities and/or huge land areas), which is impossible with other methods. The downside of rodenticides is their hazardous nature for people and domestic and wild animals. Nevertheless, if rodent control is conducted professionally and in compliance with the necessary precautions, the hazard from unintended intoxication is minumized (Janković et al., 2013; Sayer, 2017).

Rodenticides can be classified into four groups:

1. Fast-acting poisons – acute rodenticides;
2. First- and second-generation anticoagulants;
3. Gaseous rodenticides;
4. Chemosterilants.

Fast-acting – acute rodenticides

The effects of intoxication on mouse-like rodents by fast-acting rodenticides, also known as acute rodenticides, are exerted soon after a single ingestion. Depending on the poison, the first signs of intoxication and death can occur as soon as several minutes or up to 24 h after exposure. However, due to their high toxicity in small concentrations and the hazard they pose to humans and domestic and other animals, acute rodenticides are not commonly used. Moreover, some of them (e.g. sodium fluoroacetate and zinc phosphide) have no antidotes with which poisoned people or animals could be treated in cases of inadvertent intoxication. Another drawback of fast-acting rodenticides is that intoxicated rodents present abnormal behaviour (the animals suffer from cramps and produce strange sounds), which warns other individuals of the threat (Barnett, 1975). Due to their high toxicity, acute rodenticides can be used only in places where the traps can be continuously monitored and rapid extermination of whole populations of pests is necessary. This can be, for instance, the case in epidemics of rodent-borne diseases. Fast-acting poisons can also be utilized when there are overgrown populations of mice in agricultural areas, in so-called 'mouse years'. Rodent pest control services are obliged to remove and safely dispose of both all dead rodents and remains of baits 24 h after the baits are placed. Thus, the possibility of other animals consuming dead rodents and becoming intoxicated is much reduced. The group of fast-acting rodent poisons includes norbormide, α-naphthylthiourea, zinc phosphide, thallium sulphate, fluoroacetamide, barium carbonate, arsenic trioxide, strychnine, scilirozide, pyrinuron, bromethalin and calciferol.

Slow-acting rodenticides – anticoagulants

Anticoagulant rodenticides are currently the most widely used means of rodent pest control worldwide and in Serbia. In fact, anticoagulants are the only rodenticide group approved for rodent pest control in Serbia. The advantages of these rodenticides over their fast-acting counterparts are that they do not induce fear of baits and that they are safe for use. Anticoagulant rodenticides which are currently used are derivatives of hydroxycoumarine and indandione. These chemicals prevent blood coagulation and cause blood vessel disruption and haemorrhage in internal organs. As a result, after ingesting the chemical, the rodent dies of exsanguination (Taylor and Thomas, 1989). Since death caused by anticoagulants is similar to death by natural causes, these chemicals do not provoke doubt in other rodents.

It is widely known that vitamin K is effective in the recovery of mammals inadvertently intoxicated with anticoagulants by preventing haemorrhages. The risk of secondary intoxication by anticoagulants is relatively low. It could increase if animals that prey on rodents, such as cats, owls or other predatory birds, or common weasels, repeatedly consume intoxicated rodents over long times (Saravanan and Kanakasabai, 2004; Christensen et al., 2012). EU regulations prohibit the distribution of anticoagulant baits by spreader machines on agricultural land, to prevent intoxication of non-target wild animal species (Sanchez-Barbudo et al., 2012), although enforcement is inadequate. This method of dispersing loose anticoagulant baits on agricultural land is also practiced in Serbia. Pigs are extremely sensitive to anticoagulant rodenticides, which is why rodent control in premises in which pigs are kept is extremely delicate and requires special precautions to be taken.

The doses of these anticoagulants and the durations required for their continual ingestion to provoke haemorrhage and death in rodents vary, and according to these criteria, anticoagulant rodenticides can be divided into *first-generation* and *second-generation anticoagulants*.

First-generation anticoagulants

First-generation anticoagulants (chlorophacinone, diphacinone and warfarin) produce a cumulative effect and must be ingested repeatedly to cause rodent death: a single consumption of these baits, even those containing high doses of anticoagulants, will not lead to rodent death. However, multiple ingestions of small doses lead to death in 5 to 10 days. Combined administration, *via* baits treated with these poisons and dusting active holes and rat runways with anticoagulant dust, lead to even better results. As all rodents, rats and mice lick and clean their fur and, thus, ingest the poison dust that is collected when they run on dusted runways (Krajcar, 2008; Fishel, 2016).

Second-generation anticoagulants

The emergence of resistance of mouse-like rodents to first-generation anticoagulants and the tendency of these chemicals to spread further prompted the synthesis of novel anticoagulants based on hydroxycoumarins – there are currently more than twenty of them. The most widely known rodenticides in this class are difenacoum, brodifacoum, bromadiolone and difethialone. Second-generation anticoagulant rodenticides are considerably more potent than first-generation anticoagulants, since a lethal dose can be ingested in a single feeding (Fishel, 2016). The majority of these rodenticides in concentrations as low as 0.002-0.005% in baits are capable of producing 100% lethality in *R. norvegicus*. Death does not occur immediately, but in 4 to 6 days, with the same symptoms as are produced by the first-generation anticoagulants. Rodent pests ingest the baits readily due to the absence of any signs which would warn them not to do so. Extreme care must be taken about where and how to place baits laced with second-generation anticoagulants due to their exceptional toxicity for poultry and game birds

and somewhat lower toxicity for pigs, dogs, cats, predatory wild mammals and humans (Taylor and Thomas, 1989; Krajcar, 2008; RRAC, 2015; Fishel, 2016).

Proper placement of rodenticide baits

Baits can be extremely attractive to rodents. However, if placed inappropriately, the process of rodent control can fail or, more importantly, can result in inadvertent intoxication of non-target species. Specific instructions that must be followed when placing baits in both enclosed spaces and open areas are:

1. Baits treated with rodenticides must be laid in places where the largest numbers of rodents gather, which improves the chance of bait ingestion.
2. Baits must be positioned to prevent all non-target species, including humans and especially children, from approaching them.
3. Baits must not contaminate raw material, food or water intended for human and/or animal consumption.
4. Detailed plans for each baited building and open area must be kept up-to-date; the exact places where baits are laid must be carefully considered and must enable regular monitoring.
5. The exact positions/locations of baits and the quantities of baits required must be specified.
6. Baits must be laid in sufficient quantities and placed in bait boxes/bait stations or in hidden or shadowy places.
7. Paraffin baits laid in the vicinity of domestic animals must be tied with wire to non-movable posts or other objects to prevent rodent pests from carrying them away.
8. The numbers and strengths of the laid baits and their use must always be in accordance with the instructions provided by the bait manufacturer.
9. In sewer systems, water-resistant paraffin baits must be placed in such a way that water cannot wash them away.
10. Persons or companies responsible for rodent control procedures must not give rodenticide baits to end-users to place them without suitable training and supervision.

Errors in conducting rodent control

When planning a strategy for rodent control, it is crucially important to ascertain the most appropriate rodenticide formulation. Also, the type, shape and quality of baits strongly influence the success of rodent control. Generally, all rat poisons are highly effective, on condition that rodents ingest them. In other words, there are no poisons which do not work, but there are inefficient and non-acceptable baits. In spite of being curious by nature, rodents are very cautious about consuming novel food unknown to them, especially if various sources or a wide array of food is continuously accessible. Neophobia is well-known in rats and should not be neglected, irrespective of the formulations of baits (Modlinska and Stryjek, 2016). When planning and conducting

rodent control, the fact that rodents are very intelligent and cautious animals with significant memory capacity to retain and retrieve data on previous rodenticide campaigns must be borne in mind (Krajcar, 2002).

The most common errors leading to ineffective rodent control are:

1. Treatment of the premises only, but not the surrounding land area;
2. Not treating some buildings;
3. Improper choice of bait formulation;
4. Laying an insufficient number of baits;
5. Improper placement of baits;
6. Use of too few bait boxes/stations;
7. Lack of control over the baits;
8. Leaving it to an untrained end-user to plan bait strategy/use;
9. Lack of effective hygienic-sanitary measures.

These typical errors that can occur during rodent control can be avoided or remediated only by the attendance of internal professional supervision when conducting and after finishing rodent control. Only this monitoring enables the majority of errors to be easily corrected as soon as possible – i.e. during rodent control. All other mistakes, discovered in the final analysis, can be corrected by repeating corrected rodent control in the building(s) or areas where errors are detected (Krajcar, 2011; Janković et al., 2013; Janković et al., 2018).

CONCLUSION

Rodent pests are natural reservoirs and transmitters of a wide array of diseases caused by bacteria, rickettsia, viruses, protozoans, helminths and fungi to humans and animals. Rodent pests cause huge economic losses, not only by feeding on food intended for human or animal consumption, but also by their hoarding and gnawing activities spoiling the material due to contamination with excrement and hair. Control of populations of synanthropic and hemisynanthropic pest rodents is an extremely difficult and delicate issue. Thus, non-professional rodent control can have deleterious consequences for people, including workers performing the task, and non-target animal species. Only integrated deployment of preventive, mechanical, physical and chemical methods using an in-depth, well-managed plan can lead to successful control of rodent pests.

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Authors contributios

JLj, TR, PŠ, MM, ĐS, TN, and DV were participated in the design of the study, conceived of the study, and participated in its design and coordination and helped to draft the manuscript

Competing interests

The authors declare that they have no competing interests

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KONTROLA ŠTETNIH GLODARA

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Kratak sadržaj

Uvod. Štetni glodari su prirodni rezervoari, ali i prenosioci uzročnika čitavog niza bolesti na čoveka i životinje izazvanih bakterijama, rikecijama, virusima, protozoama, parazitima i gljivicama. Najveći faktor rizika za infekciju ljudi trihinelom su svinje uzgajane na manjim farmama i u seoskim domaćinstvima u kojima se deratizacija ne sprovodi redovno. Štetni glodari nanose ekonomske štete konzumirajući, zagađujući ili oštećujući hranu namenjenu ljudskoj ishrani i ishrani domaćih životinja.

Cilj i pristup. Cilj ovog rada je da ukaže na epidemiloško – epizootiloški i ekonomski značaj redovnog sprovođenja deratizacije, kao i na značaj integrisanog korišćenja svih mera u deratizaciji, kao i propusta koji nastaju tokom sprovođenja deratizacije.

Ključni nalazi i zaključak. Suzbijanje i kontrola brojnosti populacija štetnih sinantropnih i hemisinantropnih glodara predstavlja izuzetno složen i delikatan zadatak. Ako se imaju u vidu osobenosti većine vrsta štetnih glodara, kao na primer visok potencijal reprodukcije, izuzetna prilagođenost životu u najrazličitijim uslovima staništa i postizanje rezinstencije na neke rodenticide iz I generacije antikoagulanasa,problem kontrole brojnosti štetnih glodara je znatno složeniji nego što na prvi pogled izgleda. Zbog svega navedenog, za izvođenje akcije deratizacije potrebno je odgovarajuće teorijsko i praktično naučno-stručno znanje jer nestručno sprovedena deratizacija može imati nesagledive negativne posledice kako za stanovništvo i neciljane vrste, tako i za same izvođače.

Ključne reči: antikoagualansi, deratizacija, vektor