RODENTICIDES: COMPARATIVE EVALUATION OF COMMERCIALLY AVAILABLE ACTIVE SUBSTANCES AND STRATEGIES FOR SUSTAINABLE RAT MANAGEMENT

Written by:

Dr. Manfred Klade

Technical Office Klade

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CONTENT

LIST OF ABBREVIATIONS

?	Data uncertainty, data gap
Acute tox.	Harmful effect that occurs when a substance is administered orally or dermally in a single dose or inhaled.
B	Bioaccumulative or substances that accumulate in living organisms.
BCF	In the fish test, the ratio between the substance concentration in the test fish and in the test water.
BPC Op.	Opinion of the Committee for Biocidal Products (BPC)
BPR	Biocidal Products Regulation: regulates the approval of active substances and the authorisation of biocidal products
C	Carcinogens or substances that have been shown to cause or promote cancer
Chron. Tox.	Acts on a target organ with repeated exposure (chronic toxicity).
CLP Regulation	This regulates the classification, labelling and packaging of substances and mixtures.
CMR	Carcinogenic (carcinogenic), mutagenic (mutagenic), toxic to fertility (toxic for reproduction)
DT50	Quantitative measure of the degradability (half-life) of a substance in the environment in days.
ECHA	European Chemicals Argentur
ED	Endocrine disrupting or substances that influence or interfere with normal hormonal activity.
harm. C&L	EU-wide harmonised classification of particularly critical hazards (C&L Directory database).
k.H.	no indications
Karz.	Carcinogenic or increasing the incidence of cancer
Corr.	Irritating or corrosive
LD50	Amount of substance which, when administered once, causes the death of 50% of the laboratory animals within 24 hours.
M	Mutagen or substances that have been shown to change the genetic material
Muta.	Mutations in germ cells that can be passed on to offspring.
P	Persistent or substances that exceed a degradation half-life depending on the location, i.e. are difficult to degrade.
PBT	Substance that is persistent, bioaccumulative and toxic according to the criteria in Annex XIII REACH Regulation.
R	Toxic to reproduction or substances that have been shown to impair fertility or embryonic development
RAC Op.	The Committee for Risk Assessment (RAC) prepares opinions on the risks of substances.
RARE	Active substance report or dossier for the approval of an active substance

REACH	REACH Regulation: European Chemicals Law, an ECHA database provides dossiers for chemicals.
Repro.	Impairs sexual function and fertility, as well as developmental toxicity in offspring.
Sens.	Skin and/or inhalation allergen
T	Toxic or substances that harm human health and/or the aquatic environment. Criteria for human health are: proven carcinogenic, mutagenic, toxic to reproduction or toxic to target organs (chronically toxic).
UBA	Federal Environment Agency
Vb	Very bioaccumulative or substances that accumulate even more strongly in living organisms than bioaccumulative substances.
vBvP	Substance that is very persistent and very bioaccumulative according to the criteria in Annex XIII REACH Regulation.
Vp	Very persistent or substances that take even longer to degrade than persistent substances.

SUMMARY

PROBLEM OUTLINE

Anticoagulants are the means of choice in rat control at the latest with the development of second-generation active ingredients (SGAR) due to their delayed effect, high efficacy and easy handling. For a long time, there was therefore no reason to question their use and to develop further active ingredients or control methods. This view has changed at the latest since the legally binding new approval of biocides, including a comprehensive environmental risk assessment of rodenticides in the early 2010s. In the course of the risk assessment, SGARs were identified as persistent, bioaccumulative and (reproductive) toxic - in some cases highly - persistent. Several studies have also shown that high concentrations of rodenticide residues could be detected in dead animals found in many non-target species, such as in (rare) birds of prey, foxes or strictly protected hamsters. These worrying negative effects on the environment highlighted the urgent need for more environmentally friendly alternatives to rat control.

In addition, anticoagulants cause days of pain and thus animal suffering by causing internal bleeding. For this reason, too, their use is only justifiable if all conceivable measures have been taken beforehand to contain the rodent infestation and there is also no alternative to the use of this group of active ingredients. In the period between the documentation of the risks and the renewal of the approvals of the 2nd generation anticoagulants, no less questionable alternatives came onto the market. Thus, despite continuing reasons for non-approval (exclusion criterion: reproductive toxicity), the EU regulatory authority was forced to continue to authorize the even more toxic active ingredients of the second generation (SGAR) in addition to the anticoagulants of the first generation (SGAR) due to a lack of sufficient alternatives – with considerable conditions or restrictions on their use [1], [2]. However, the requirements have so far done little to change the fact that anticoagulants are widespread in the environment [3].

For the City of Vienna, beyond the general environmental risk, the question arises as to whether the use of baits laced with anticoagulants harms the European hamster population living in the city area and strictly protected under nature conservation law. This is because these non-target animals have a comparable food spectrum and a habitat that overlaps with rats. Concrete cases of poisoning of hamsters through the direct eating of rat baits containing rodenticides could be proven.

In addition, the Vienna City Council adopted the "Vienna Strategy for Pesticide Minimization" in March 2022 [8]. As part of the implementation, measures are also to be taken to reduce the use of biocides in the city as much as possible. As part of the Vienna Strategy for Pesticide Minimization, the *Biocide Reduction Working Group was* therefore founded in Vienna, which was set up by the Vienna Environmental Ombudsman's Office in 2023 and has been headed since then. The working group is currently working on the topic *of sustainable rat management*. In this context, a possible amendment to the Vienna Rat Ordinance is also being discussed. To this end, working meetings were held in 2023 and 2024 with the participation of affected departments and (external) stakeholders [7]. The working group's team of experts is to develop solutions for sustainable rat management and propose them to politicians. The topic of the use of anticoagulants for rat control and possible chemical as well as non-chemical alternatives is central. Among other things, the following questions will be addressed: Are there effective material alternatives to anticoagulants that are less harmful to the environment and

non-target animals? Are there effective rat control measures of a non-material nature and how practicable are they?

QUESTIONS OF THE STUDY

The Klade Technical Office was commissioned by the Vienna Environmental Ombudsman's Office to compares the inherent hazard potential of rodenticides approved in the EU and thus also in Austria to accompany the above-mentioned working group. In addition, international best practice examples of rat management in urban areas are researched. The knowledge or evaluations developed in the study will be passed on to the working group. The evaluation is intended to enable a weighing of individual active substances. The questions addressed by the study are:

- Are there differences within the group of rodenticides currently used (active ingredients of the first and second generation) in terms of effect and environmental effect (i.e. with regard to primary and secondary poisoning, bioaccumulation and persistence) that make it possible to recommend individual active ingredients over others?
- Are there viable chemical or non-chemical alternatives to anticoagulants?
- What measures characterize successful rat management in urban areas?
- Which measures are particularly effective in avoiding or reducing the use of anticoagulants?

RESULTS

Rodenticidal active ingredients are regulated by the EU's Biocidal Products Regulation. While biocidal active ingredients are approved by the EU, the approval of commercial products is the responsibility of the nation states. Rodenticides according to product type 14 are defined as active substances or products for the control of mice, rats and other rodents by means other than repellent or bait. The main research and evaluation results are:

Authorisation and classification of rodenticidal active substances

The appendix table contains all active substances of product type 14 (rodenticides) listed in the database of the European Chemicals Agency ECHA.

Of the 16 active ingredients listed, 10 are anticoagulants or anticoagulants: chlorophacinone, coumatetralyl, warfarin, warfarin sodium, brodifacoum, difethialone, floucumafen, bromadiolone, difenacoum, alpha-bromadiolone.

The following are not to be assigned to the anticoagulant mode of action: phosphine-releasing aluminium phosphide, hydrogen cyanide, carbon dioxide, cholecaciferol, alpha-chloralose, powdered corn cobs.

The approval process for alpha-bromadiolone is ongoing, and 11 active substances are currently approved. The approval has expired for: warfarin, warfarin sodium, carbon dioxide and powdered corn cobs.

Hazard potential of rodenticidal agents

A hazard analysis of 15 active substances was carried out (see Table 1). The warfarin sodium was excluded from the analysis because its approval expired in January 2017. This analysis is essentially based on the classifications and data from the documents prepared in the context of the biocide authorisation. The ABC categorization based on this and used for better comparability of inherent substance properties is taken from the disinfectant database WIDES [9]. In the hazard analysis, the respective classifications of the hazardous properties of substances (H-phrases) or data gaps are assigned to one of three categories. Category A (red) indicates a high hazard potential, category B (yellow) a medium hazard potential and category C (white) a low hazard potential.

As far as anticoagulants are concerned, the analysis indicates a very high risk due to H360D ("may harm the child in the womb") (red field). All anticoagulants are classified as very toxic with H300 ("danger to life if swallowed"), H310 ("danger to life in case of skin contact") and H330 ("danger to life if inhaled"). Anticoagulants have no irritant or corrosive effect and are not sensitizing (white fields: "low concern"). As far as the hazard to surface waters is concerned, a more differentiated picture emerges based on the classifications: For example, warfarin with H411 is only moderately hazardous to water, while difethialone with H410 and an M factor of 100 is highly hazardous to water. However, since the assessment of the environmental hazard must take into account not only the classification but also the bioaccumulation behaviour and the longer-term degradability, a complete picture only emerges in the detailed analysis.

The substances phosphine, hydrogen cyanide/hydrogen cyanide and carbon dioxide, which act via the gas phase, do not show any CMR properties. While phosphine and hydrogen cyanide are roughly comparable to anticoagulants in terms of toxicity, carbon dioxide shows no intrinsic toxicity. Cholecalciferol is both acutely and chronically toxic. A water hazard cannot be assumed due to the lack of classification, nor CMR properties. The active ingredient alpha-chloralose is moderately acutely toxic or hazardous to water and does not show any CMR properties.

CMR, PBT, vPvB and endocrine (ED) properties of rodenticidal agents

The following properties of rodenticidal agents are presented in Table 2 as an overview: CMR properties are proven carcinogenic (C), mutagenic (M), and/or reprotoxic (R) properties. If substances have endocrine properties (ED), they influence or disrupt normal hormonal activity in humans and/or organisms in the environment. PBT or vPvB properties are: persistent (P), bioaccumulative (B), toxic (T), very persistent (vP), very bioaccumulative (vB). Substances with these properties are (very) difficult to degrade in the environment (i.e. persistent), accumulate in the organisms and thus in the food chain (i.e. are bioaccumulative) and/or very toxic to humans and the environment. If one of the properties mentioned is detected in the process of approving the active substance, this circumstance leads to a refusal of the approval – unless the active ingredient is necessary or indispensable to combat a serious danger to humans, animals or the environment. This exemption provided for in the Biocidal Products Regulation applies to anticoagulants, the main reason for which is the lack of comparably effective alternatives. It has been known for a long time that all anticoagulants have been proven to be toxic to reproduction and, as CMR substances, would be affected by non-approval. Table 2 shows that all 5 second-generation anticoagulants have PBT or even vPvB properties. These characteristics also lead to an exclusion from approval. However, cholecaciferol as an alternative to anticoagulants would also be affected: The active ingredient does not have CMR, PBT or vPvB properties. However, it has an endocrine effect, which is also an exclusion criterion. But just like the anticoagulants, cholecalciferol is approved under an exemption.

Product approvals in the EU and Austria

Table 3 shows the number of commercial products authorised in the EU or Austria as well as examples for each active substance. The figures indicate the great importance of the SGAR active ingredients: Brodifacoum, Bromadiolone and Difenacoum are approved in more than 500 products in the EU. There are 113 products for alpha-chloralose in the EU and 24 products in Austria. 10 products are based on the active ingredient phosphine (EU), hydrogen cyanide is only contained in one product in the EU as well as in Austria. Cholecaciferol is approved in the EU as well as in Austria in 3 products. Only the active ingredients coumatetralyl and alpha-chloralose are also approved for private use.

Detailed analysis of individual active ingredients

The presentation made in the chapter Detailed Analysis is based on data generated within the framework of the CLP Regulation and REACH as well as the Biocidal Products Regulation. The human toxicological hazards derived from the classification are again represented by means of a colour code. For the 8 anticoagulants, acute toxicity measurements and substance data relevant to the PBT and vPvB criteria were also researched. This was intended to make any differences in the extent of the risk visible within the group of anticoagulants. Exclusion criteria relevant for admission are made visible. The number of product approvals in the EU and Austria is also cited as a measure of market relevance. Information is linked to the corresponding sources. There is also information on the use and principle of action based on the approval documents. The concrete results for each active ingredient can be read in the chapter Detailed analysis, they are difficult to summarize here.

Alternatives to anticoagulants

This section analyses whether and to what extent there is no alternative to the use of anticoagulants in rat control. This question already arises from the authorisation of the same, because not only do all authorised anticoagulants meet the exclusion criterion under Article 5 (i.e. they are authorised only for socio-economic reasons), but also the substitution criterion (i.e. they should be replaced where possible). The reasons are sufficiently known and documented and are only briefly outlined: All second-generation active ingredients (SGAR active ingredients) have PBT and – with the exception of bromadiolone – also vPvB properties. This means that they are poorly degradable and accumulate in the environment and in living organisms. The adverse effects of FGAR active substances, but in particular of second-generation active substances (SGAR active ingredients) compared to non-target animals and their fate in the environment, have been extensively documented [1]. Unintentional poisoning of non-target animals caused by anticoagulants is referred to as primary and secondary poisoning. Primary poisoning occurs when non-target animals eat bait and thus ingest the poison. This applies, for example, to animals that share a habitat with the rodents or have a comparable food spectrum. Secondary poisoning occurs when predatory mammals or birds of prey eat poisoned rodents and thus absorb the active ingredient. It should also not be forgotten that due to the high toxicity of the baits, pets and small children are also endangered by direct exposure. For Austria, a study by the Federal Environment Agency shows that foxes, birds of prey and fish are significantly contaminated by anticoagulants, especially of the second generation, but also of the first generation [3].

<u>Can anticoagulants be replaced by more environmentally friendly alternatives? (chemical alternatives)</u>

Phosphine, hydrogen cyanide and carbon dioxide (approval expired!) are only effective via the gas phase and require a special application context (only trained users, indoors or in closed areas). The advantage of the active ingredients is that although they have an acute (highly) toxic effect, they do not have CMR, PBT or vPvB properties. Alpha-chloralose is a narcotic that can usually only be used successfully in smaller organisms (rather mice) and indoors. However, its market relevance for this

application is significant (see Table 3). Finally, the active ingredient cholecalciferol (e.g. the commercial product: Selontra) is a relevant alternative to anticoagulants. It can be used in a similar way and kills with a delay, which is why the phenomenon of food shyness is avoided. However, its endocrine activity entails a direct or indirect threat to predators. This active ingredient also falls under Article 5 (non-authorisation due to the exclusion criterion of hormonal activity), but it is subject to the exemption for authorisation, as is the case with anticoagulants. Overall, cholecalciferol remains due to the lack of PBT or vPvB properties are not in the environment for a long time, which in turn can be seen as an advantage in application.

Is it possible to differentiate within the group of anticoagulants in terms of effect and environmental effect (primary and secondary poisoning, bioaccumulation, persistence)?

It is known and proven by the data on acute toxicity as well as PBT, vPvB properties that first-generation drugs (FGAR) are not persistent or bioaccumulative like all second-generation drugs (SGAR), but have a lower efficacy against rats, also due to increasing resistance in rats over the decades. In practice, this means that first-generation drugs only lead to the death of the target animal after repeated ingestion and therefore there is a higher risk of developing resistance. The fact that this does not necessarily have to lead to a complete replacement of FGAR with SGAR active ingredients is shown by the best practice example in Zurich: There, city employees continue to use the FGAR active ingredient coumatetralyl and only use an SGAR active ingredient to break resistance.

In addition to its own data research and evaluations, a concept study by the Federal Environment Agency on the development possibilities of an environmentally compatible rodenticide was evaluated, which offers a comparative semi-quantitative point evaluation of approved active substances [2]. Not only aspects of the environmental impact are included in the assessment, but also of economic efficiency and practicability. The criteria are not weighted in relation to each other (see figures on pages 39 & 40). In this assessment, the chemical alternatives hydrogen cyanide/hydrogen cyanide, cholecalciferol and alpha-chloralose perform better overall than the anticoagulants. Within the anticoagulants, coumatetralyl, warfarin (approval expired) and difethialone perform relatively favourably, while difenacoum and bromadiolone perform relatively unfavourably. In the case of Brodifacoum, the (very) poor environmental assessment is cancelled out by the good practicability and low costs and it thus lands in the middle of the field.

Fall

Snap traps can be more animal welfare-friendly than poisons if they are designed and used correctly, even if the user may intuitively think the opposite, as it is possible that the setting up of snap traps may make them much more aware that it is about killing animals. This is also the case through the application of poisons, but here the death of the rodents usually takes place in secret. Previous tests indicate that snap traps, when used correctly, can cause less animal suffering when killing rodents than poisoning with anticoagulants. UBA is committed to improving the overall quality and justifiability of biocide-free alternatives in the future and to developing test methods and guidelines for their assessment. At present, however, there is no testing or approval body for rodent traps in Germany or Austria [1]. Rats are also too clever to fall into snap traps, the effect of which they have already observed in conspecifics.

Key factors for successful rat management

In practice, it is mainly medium-sized to large cities that have to deal with the issue of rat management. The control of rats by using anticoagulants and other biocidal agents in bait boxes is an important, but by no means the only and most important measure that is relevant in connection with successful

rat management. The examples given in the urban environment make it clear that human resources, the implementation of a central point of contact in the city administration, the intensity of communication with the population, administrative options, the use of innovative technologies for monitoring, as well as appropriate waste and wastewater management have a considerable influence on the rat population existing over time and thus on the required quantities of environmentally harmful rodenticides. In the best practice examples, the implementation of comprehensive rat management has resulted in a significant reduction in the quantities of rodenticides used per unit of time, and the following measures appear to be particularly effective:

Establishment of a central point of contact and coordination

It is important that a central point of contact in the municipal administration is adequately staffed, that it has the necessary competencies and that the procedures are standardized (such as the measures taken in each case in the event of rat reports). The advantage is that the information about the rat infestation and various existing hotspots converges in one place in the city, giving a better picture of the status quo. This improves the chances of clarifying and eliminating the causes of rat hotspots. Ideally, this office should also take over communication with the public (persons to be reported, those responsible in infested areas or in the building sector, with other offices and the press) as well as public relations work itself (flyers, apps, mailing, etc.).

Monitoring and documentation of rat infestation

The central point of contact and coordination should take over the monitoring (interpretation of feeding baits in rat reports) or at least be involved. The use of tools such as GIS maps or databases is helpful here. The installation of permanent bait boxes in Bonn serves as an indicator of infestation pressure. A reporting system, in which professional pest controllers can also report rat sightings and measures or even have to do so, would also enormously increase the overview of the actual population dynamics of the urban rat population.

Consideration of infestation dynamics

An essential element of monitoring as well as of the actual control is the consideration of aspects that can be described as "infestation dynamics". According to the statements of those responsible in the analyzed best practice examples, rats have a tendency to stay in territories and only change territories under certain conditions. Therefore, a rat infestation seems to occur more clustered and less distributed over the area. It is assumed that this circumstance should be taken into account in the overall concept of rat management.

Waste management

What is meant is that the access of rats to waste of all kinds should be made more difficult or prevented. This applies to open garbage cans, garbage baskets or bird food. Legal measures or ordinances can contribute to this, which enable the city administration to have appropriate enforcement competence if necessary.

Legal regulation for the acquisition and use of anticoagulant rodenticides (Austrian Rodenticide Expert Ordinance).

A significant step forward for the use of anticoagulants in Austria is the Rodenticide Expert Ordinance (Federal Law Gazette II No. 246/2024), which was drafted by the Federal Ministry for Climate Protection and will come into force on 1 January 2026. The aim of the ordinance is a professional, careful and risk-minimizing handling of anticoagulant rodenticides by professional users (e.g. farmers, mu-

nicipal workers, tradespeople). Thus, the supply of anticoagulant rodenticides approved for professional use is only possible to trained "competent professional users". In addition to the training of professional users, the regulation also provides for training of the trade. They must train knowledgeable distributors who can provide buyers with appropriate advice and the necessary knowledge to minimise risk.

Wastewater management

A well-functioning sewer system with few opportunities for rats to retreat and nest limits the infestation per se. This circumstance was or is taken into account in the best practice examples. In Zurich, for example, sewer systems are routinely renovated over time or flushed regularly. In addition , private, damaged or even open house sewers (e.g. after the demolition of buildings) are a problem, as they offer nesting opportunities for rats and allow easy access to the surface and other food sources. Their discovery and rehabilitation is of great relevance.

Access to private property

Although those responsible for rat management in urban areas primarily look after public spaces above and below ground, it is unavoidable to investigate the causes on site when rat sightings are reported on private property. Accordingly, there is a need for control or remediation measures in the private sector. The examples show that although an agreement with the owner by consensus is sought as a first step, it is not always possible. It is therefore relevant that the intervening body can, if necessary, successfully remedy sanitary deficiencies even against the will of the owner on the basis of sufficient legal foundations, without having to burden the general public with the costs. In Zurich, for example, seizures can be made in such cases.

Technical investments

The market offers a wealth of offers in terms of bait boxes (systems in combination with waste bins), etc., which are equipped with tools (cameras, sensors, etc.) or electronically networked. The study did not conduct a survey on this point, but only evaluated indications from the best practice examples. It should be borne in mind that although corresponding technical investments incur costs in advance and in the context of data reading and maintenance, they can help to find the optimal positioning of boxes and completely wipe out individual rat territories. Recolonization usually takes place over the course of months. As soon as digitized bait boxes can also be read from the street (here the radio technology possibilities are currently still missing), the costs for operation would fall significantly.

Targeted and economical use of anticoagulants

The implementation of the measures mentioned should result in savings in the use of anticoagulants over time. In addition, the selection of active ingredients can also take into account what was mentioned in the Zurich best practice example: first-generation anticoagulant active ingredients (e.g. coumatetralyl) can also be used. A second-generation active ingredient can be used as a resistance breaker if necessary. This could help to further reduce the quantities used in SGAR, which are known to be the most environmentally hazardous.

Replacement of anticoagulants

In the best practice examples, only the active ingredient cholecalciferol was mentioned or used as an alternative to anticoagulants. The indoor use of (snap) traps was also mentioned.

OVERVIEW TABLES ACTIVE INGREDIENTS

Active substances for the control of mice, rats and other rodents (rodenticides or product type 14) are approved in the EU under the Biocidal Products Regulation (BPR). Of the 16 rodenticides listed in the ECHA database, 11 are currently authorised. The approval has expired for 4 active ingredients, and the approval for 1 active ingredient is ongoing. In the tables, the active ingredients are arranged according to their principle of action as far as possible:

- First generation anticoagulation: chlorophacinone, coumatetralyl, warfarin (discontinued), warfarin sodium (discontinued)
- Second-generation anticoagulation: brodifacoum, difethialone, flocoumafen, bromadiolone, difenacoum, alpha-bromadiolone
- Active ingredients via the gas phase: phosphine-releasing aluminium phosphide, hydrogen cyanide, carbon dioxide (leaked)
- Other active ingredients: cholecalciferol, alpha-chloralose, powdered corn cobs (discontinued).

Explanations of the tables

Table 1: Contains all H-phrases relevant for ABC categorization and their assignment to an assignment to the color code (red, yellow, white). A comprehensive compilation and justification of the assignments of category and H-sentence can be found in the pdf "Introduction to the Evaluation Grid" downloadable from the homepage of the WIDES database [9].

Table 2: Contains the ABC categorization of each rodenticidal active ingredient sorted according to 6 hazard categories: Acute toxicity, irritant, corrosive effect, sensitization, CMR & chronic toxicity as well as hazard to surface waters (acute or chronic). A comprehensive compilation and justification of the assignments of H-phrase and hazard category can be found in the pdf "Introduction to the Assessment Grid" downloadable from the homepage of the WIDES database [9].

Table 3: Indicates for each rodenticidal active substance which exclusion criteria are met according to the marketing authorisation documents.

Table 4: Provides an overview of product approvals and user categories. The number of approvals in the EU and the number in the Austrian Biocidal Product Directory are listed for each active substance. In addition, products approved in Austria are listed as examples for each active ingredient as well as the permissible (x) user categories according to the Austrian Biocidal Products Inventory.

TABLE 1: ABC CATEGORIZATION BASED ON H-PHRASES AND THEIR COLOR CODES (CATEGORY).

Category A (very high concern) covers substances that cause high and/or irreversible hazards in low concentrations	
H372	Damages organs during prolonged or repeated exposure (target organ)
H360D	May harm the child in the womb.
H410 (M100)	Very toxic to aquatic life with long-term effects with M-factor 100
Category B (major concern) covers substances with significant adverse effects on health and the environment	
H300, H301	Danger to life or toxic if swallowed
H310, H311	Danger to life or toxic in contact with skin
H330, H331	Danger to life or toxic if inhaled
H400 (M ≥ 10)	Very toxic to aquatic life with M-factor[1] equal to or greater than 10
H410 (M ≥1)	Very toxic to aquatic organisms with long-term effects with M-factor 11 equal to or greater than 1
?	Data gap or data uncertainty
Category C (low concern) covers limited, controllable and/or reversible hazards	
H400 (M1)	Very toxic to aquatic organisms with M-factor1
-	On the basis of available data, a risk can be ruled out

[1] Multiplication factor, which weights highly toxic substances accordingly. In this case, the M-factor is 1

TABLE 2: OVERVIEW OF THE ABC CATEGORIZATION OF RODENTICIDES

Nr	Eintrag für Produktart PT 14	Akute Giftigkeit (Akut Tox.)	Reiz-, Ätzwirkung (Korr.)	Sensibilisierung (Sens.)	CMR & chronische Toxizität (CMR & chron. Tox.)	Gefährdung Oberflächen gewässer (Aq. Tox. akut)	Gefährdung Oberflächen gewässer (Aq. Tox. chronisch)
Antikoagulantien 1. Generation (FGAR)							
1	Chlorophacinon	H300, H310, H330	-	-	**H372 (Blut), H360D**	H400 (M1)	H410 (M1)
2	Coumatetralyl		-	-		-	H410 (M10)
3	Warfarin		-	-		-	H411
Antikoagulantien 2. Generation (SGAR)							
4	Brodifacoum	H300, H310, H330	-	?	**H372 (Blut), H360D**	H400 (M10)	H410 (M10)
5	Difethialon		-	-		H400 (M100)	**H410 (M100)**
6	Flocoumafen		-	-		H400 (M10)	H410 (M10)
7	Bromadiolon		-	-		H400 (M1)	H410 (M1)
8	Difenacoum		-	-		H400 (M10)	H410 (M10)
9	alpha-Bromadiolon		?	?		?	H412
Wirkstoffe über die Gasphase							
10	Phosphin freisetzendes Aluminiumphosphid	EUH029, H300, H311, H330	?	?	?	H400 (M100)	?
11	Cyanwasserstoff	H300, H310, H330	?	?	**H372 (Schilddrüse)**	H400 (M?)	H410 (M?)
12	Kohlendioxid	-	-	-	-	-	-
Sonstige Wirkstoffe							
13	Cholecalciferol (Vitamin D3)	H300, H310, H330	-	-	**H372 (alle Aufnahmewege)**	-	-
14	alpha-Chloralose	H301, H332, H336	-	-	?	H400 (M10)	H410 (M10)
15	Maiskolben, pulverisiert	-	-	-	-	-	-

TABLE 3: DETAILED ANALYSIS OF EXCLUSION AND SUBSTITUTION CRITERIA FOR RODENTICIDES

Nr	Eintrag ECHA für Produktart PT 14	Ausschlusskriterien [Art 5(1) BPR]								Substitutionskriterium [Art 10 BPR]
		C	M	R	PBT			vPvB	ED	
					P	B	T			
Antikoagulantien 1. Generation (FGAR)										
1	Chlorophacinon	-	-	✓	✓	-	✓	-	-	✓
2	Coumatetralyl	-	-	✓	-	-	✓	-	-	✓
3	Warfarin	-	-	✓	-	-	✓	-	-	✓
4	Warfarinnatrium	-	-	✓	-	-	✓	-	-	✓
Antikoagulantien 2. Generation (SGAR)										
5	Brodifacoum	-	-	✓	✓	✓	✓	-	-	✓
6	Difethialone	-	-	✓	✓	✓	✓	✓	-	✓
7	Flocoumafen	-	-	✓	✓	✓	✓	✓	-	✓
8	Bromadiolon	-	-	✓	✓	✓	✓	-	-	✓
9	Difenacoum	-	-	✓	✓	✓	✓	✓	-	✓
10	alpha-Bromadiolon	-	-	✓	?	?	✓	?	k.H.	✓
Wirkstoffe über die Gasphase										
11	Phosphin freisetzendes Aluminiumphosphid	-	-	-	-	-	✓	-	k.H.	-
12	Cyanwasserstoff	-	-	-	-	-	✓	-	k.H.	-
13	Kohlendioxid	-	-	-	-	-	-	-	-	-
Sonstige Wirkstoffe										
14	Cholecalciferol (Vitamin D3)	-	-	-	-	-	✓	-	✓	✓
15	alpha-Chloralose	-	-	-	✓	-	✓	-	**?**	✓
16	Maiskolben, pulverisiert	-	-	-	-	-	-	-	-	-

TABLE 4: OVERVIEW OF PRODUCT AUTHORISATIONS AND CATEGORIES OF USE OF RODENTICIDES

Nr	Stoffbezeichnung	Zulassung	Zugelassene Produkte EU	Produkteinträge mit Handelsnamen Österreich		Auswahl Handelsnamen (Biozidprodukte Verzeichnis Österreich)	Verwenderkategorie		
							Private (NBV)	Berufsmäßige Verwender (BV)	Berufsmäßige Verwender mit Zusatz qualifikation (BVZ)
Antikoagulantien 1. Generation (FGAR)									
1	Chlorophacinon	zugelassen	16	0	-	-	-	-	-
2	Coumatetralyl	zugelassen	20	13	-	SECUVERD 27; Ratten Portionsköder; Ratten Getreideköder	(x)	x	x
3	Warfarin	ausgelaufen	14	15	Wirkstoffzulassung ausgelaufen	alpharatan-RAT-disk; CURATTIN Rattenscheiben; EPYRIN-Star	-	x	x
4	Warfarinnatrium	ausgelaufen	0	0	Wirkstoffzulassung ausgelaufen	-	-	-	-
Antikoagulantien 2. Generation (SGAR)									
5	Brodifacoum	zugelassen	567	103	Gültigkeit zum Teil ausgelaufen	Murin Köderblock Facoum; Murin Facoum Pasta	-	x	x
6	Difethialon	zugelassen	23	17	Gültigkeit zum Teil ausgelaufen	Brumolin Forte; Rodilon Trio Getreidekörner	-	x	x
7	Flocoumafen	zugelassen	7	10	-	STORM pellets; STORM happen; STORM Ultra	-	x	x
8	Bromadiolon	zugelassen	552	63	Gültigkeit zum Teil ausgelaufen	Bromadiolone Granule Baits; Interratox Pellets	-	x	x
9	Difenacoum	zugelassen	506	57	-	Murin Dife pasta Girasole; Raider Köderpads; frunax DS Rattenriegel	-	x	x
10	alpha-bromadiolone	laufend	0	0	-	-	-	-	-
Wirkstoffe über die Gasphase									
11	Phosphin freisetzendes Aluminiumphosphid	zugelassen	10	0	-	-	-	-	-
12	Cyanwasserstoff	zugelassen	1	1	-	BLUEFUME	-	-	x
13	Kohlendioxid	ausgelaufen	3	2	Wirkstoffzulassung ausgelaufen	Radar; Ekomille CO2	-	-	x
Sonstige Wirkstoffe									
14	Cholecalciferol (Vitamin D3)	zugelassen	3	3	-	Selontra; Relpexa; Harmonix Rodent Paste	-	x	x
15	alpha-chloralose	zugelassen	113	24	Gültigkeit zum Teil ausgelaufen	Cumarax Mäuse-Köder Getreide; RAIDER Mäuseköder Alpha	(x)	x	x
16	Maiskolben, pulverisiert	ausgelaufen	0	0	Wirkstoffzulassung ausgelaufen	-	-	-	-

DETAILED ANALYSIS OF ACTIVE INGREDIENTS

The documents used in the detailed analysis are not listed in the bibliography regarding the authorisation and classification of active substances and products. The documents referenced below are provided with a link or can be searched on the ECHA website. For abbreviations used, see **List of abbreviations** .

FGAR ACTIVE INGREDIENTS

Chlorophacinone (CAS 3691-35-8)

Chlorophacinone is approved, there is an active ingredient report and an opinion of the BPC. The active ingredient is classified harmoniously, and a RAC Opinion is available. Chlorophacinone is classified as acutely toxic due to the low lethal dose orally, dermally and inhaled in rats (LD50) ("danger to life in the event of ingestion, skin contact or inhalation") [10], [11], [12].

TABLE 5: LD50 VALUES OF CHLOROPHACINONE

	oral (mg/kg bw)	Dermal (mg/kg bw)	inhalation (mg/l)
LD50 (Rat)	3,15	0,329	0,093

The active ingredient is toxic to fertility (H360D) and toxic to the target organ (H372; target organ: blood). A corrosive, skin-sensitizing, mutagenic or carcinogenic hazard is not to be assumed.

Stoffbezeichnung	CAS Nummer	Datenquelle(n) für ABC Kategorisierung	Akute Giftigkeit (Akut Tox.)	Reiz-, Ätzwirkung (Korr.)	Sensibilisierung (Sens.)	CMR & chronische Toxizität (CMR & chron. Tox.)	Gefährdung Oberflächen gewässer (Aq. Tox. akut)	Gefährdung Oberflächen gewässer (Aq. Tox. chronisch)
Chlorophacinone	3691-35-8	harm. C&L; RAC-Op.; BPC-Op.	H300, H310, H330	-	-	**H372 (blood), H360D**	H400 (M1)	H410 (M1)

ILLUSTRATION 1: CLASSIFICATIONS AND ABC CATEGORIZATION OF CHLOROPHACINONE

Water toxicity, PBT & vPvB criteria, environmental behaviour

Chlorophacinone is persistent but not bioaccumulative and does not meet the PBT criteria.

TABLE 6: PERSISTENCE, BIOACCUMULATION POTENTIAL AND TOXICITY OF CHLOROPHACINONE

	P	Vp	B	Vb	T
Measurement variable	DT50 (floor)		BCF		CMR; STOT RE; NOEC (aq.)
Criterion	> 120 days	> 180 days	> 2000	> 5000	
Chlorophacinone	128 days		22,75		H360 D
Assessment	persistent	-	-	-	R

Exclusion criteria, conditions for approval, application, market relevance

The active ingredient is a CMR substance and thus fulfils the exclusion criterion under Art. 5 para. 1 BPR. Approval is subject to conditions relating to application patterns: for commercial use and general public in and around buildings, for commercial purposes in sewers, for commercial purposes in open

areas and landfills. Chlorophacinone is approved in the EU in 16 products, but there are no products in the Austrian Biocidal Products Directory [13][14].

Coumatetralyl (CAS 5836-29-3)

Coumatetralyl is approved, there is an active ingredient report and an opinion of the BPC. The active ingredient is classified in a harmonised manner (RAC Opinion). Coumatetralyl is associated with H300, H311 & H330 ("danger to life if: ingestion, inhalation; Toxic in contact with the skin"), [15], [16].

TABLE 7: LD50 VALUES OF COUMATETRALYL

	oral (mg/kg bw)	Dermal (mg/kg bw)	inhalation (mg/l)
LD50 (Rat)	15 – 30	258	0,039

The active ingredient is toxic to fertility (H360D) and toxic to the target organ (H372; target organ: blood). A corrosive, sensitizing, mutagenic or carcinogenic hazard is not to be assumed.

Stoffbezeichnung	CAS Nummer	Datenquelle(n) für ABC Kategorisierung	Akute Giftigkeit (Akut Tox.)	Reiz-, Ätzwirkung (Korr.)	Sensibilisierung (Sens.)	CMR & chronische Toxizität (CMR & chron. Tox.)	Gefährdung Oberflächen gewässer (Aq. Tox. akut)	Gefährdung Oberflächen gewässer (Aq. Tox. chronisch)
Coumatetralyl	5836-29-3	harm. C&L (RAC-Op.)	H300, H311, H330	-	-	**H372 (blood), H360D**	-	H410 (M10)

FIGURE 2: CLASSIFICATIONS AND ABC CATEGORIZATION OF COUMATETRALYL.

Water toxicity, PBT & vPvB criteria, environmental behaviour

Coumatetralyl is not easily degradable, the NOEC value for fish is 0.005 mg/l. This results in the classification H410 (M factor 10) or a significant water toxicity. The active ingredient is non-persistent and non-bioaccumulative and therefore does not meet the PBT (or vPvB) criteria.

TABLE 8: PERSISTENCE, BIOACCUMULATION POTENTIAL AND TOXICITY OF COUMATETRALYL.

	P	Vp	B	Vb	T
Measurement variable	DT50 (floor)		BCF		CMR; STOT RE; NOEC (aq.)
Criterion	> 120 days	> 180 days	> 2000	> 5000	
Coumatetralyl	< 30 days		11,4		H360 D
Assessment	-	-	-	-	R

Exclusion criteria, conditions for approval, application, market relevance

The active ingredient is a CMR substance and thus fulfils the exclusion criterion according to Art. 5 para. 1 BPR. Coumatetralyl is approved in 20 products according to the ECHA database. There are 13 product entries in the Austrian Biocidal Products Directory. The categories of users listed also include private use [14], [15].

Warfarin (81-81-2)

Warfarin is no longer approved (expired) as a rodenticidal active ingredient! There is an active substance report and an opinion of the BPC, as well as a harmonized classification, a RAC opinion, and a REACH dossier. Warfarin is classified as H300, H310 and H330 ("danger to life in the event of ingestion, skin contact or inhalation") [17], [18].

TABLE 9: LD50 VALUES OF WARFARIN

	oral (mg/kg bw)	Dermal (mg/kg bw)	inhalation (mg/l)
LD50 (Rat)	5,62	40	< 0.005

Warfarin is toxic to fertility (H360D) and chronically toxic (H372; target organ: blood), a corrosive and skin-sensitizing hazard is not assumed according to RAC Opinion.

Stoffbezeichnung	CAS Nummer	Datenquelle(n) für ABC Kategorisierung	Akute Giftigkeit (Akut Tox.)	Reiz-, Ätzwirkung (Korr.)	Sensibilisierung (Sens.)	CMR & chronische Toxizität (CMR & chron. Tox.)	Gefährdung Oberflächen gewässer (Aq. Tox. akut)	Gefährdung Oberflächen gewässer (Aq. Tox. chronisch)
Warfarin	81-81-2	harm. C&L (RAC Op.), REACH	H300, H311, H330	-	-	H372 (blood), H360D	-	H411

FIGURE 3: CLASSIFICATIONS AND ABC CATEGORIZATION OF WARFARIN

<u>aquatic toxicity; PBT & vPvB criteria; Environmental performance</u>

Warfarin is easily degradable, the NOEC value for Daphnia Magna is 0.059 mg/l. This results in the classification H411 or low water toxicity. The degradation of the active ingredient in the soil is concentration-dependent, the DT50 value at realistic soil concentrations of 2 mg/kg is 2 days. Warfarin is not bioaccumulative and therefore does not meet the PBT (or vPvB) criteria.

TABLE 10: PERSISTENCE, BIOACCUMULATION POTENTIAL AND TOXICITY OF WARFARIN

	P	Vp	B	Vb	T
Measurement variable	DT50 (floor)		BCF		CMR; STOT RE; NOEC (aq.)
Criterion	> 120 days	> 180 days	> 2000	> 5000	
Warfarin	2 days (at 2 mg/kg)		21,6		H360 D
Assessment	-	-	-	-	R

<u>Exclusion criteria, requirements for (product) approval</u>

The active ingredient is a CMR substance and thus fulfils the exclusion criterion according to Art. 5 para. 1 BPR. Warfarin is approved in 14 products according to the ECHA database. In the Austrian Biocidal Products Directory there are 15 product entries that are limited to professional use [14], [17].

SGAR ACTIVE INGREDIENTS

Brodifacoum (CAS 56073-10-0)

There is an active ingredient report and an opinion of the BPC on the approved active ingredient. Brodifacoum is classified harmonized, for which a RAC opinion is available. Brodifacoum is classified as H300, H310 and H330 ("danger to life in the event of ingestion, skin contact or inhalation") [19], [20].

TABLE 11: LD_{50} VALUES OF BRODIFACOUM

	oral (mg/kg bw)	Dermal (mg/kg bw)	Inhalation (mg/l)
LD50 (Rat)	0,4	3,6	0,003

Brodifacoum is toxic to fertility (H360D) and chronic toxic (H372; target organ: blood), a corrosive hazard is excluded in the active ingredient report. The RAC Opinion and the Active Substance Report do not contain a classification as skin sensitizing, but the ECHA Infocard [20] provides information on this.

Stoffbezeichnung	CAS Nummer	Datenquelle(n) für ABC Kategorisierung	Akute Giftigkeit (Akut Tox.)	Reiz-, Ätzwirkung (Korr.)	Sensibilisierung (Sens.)	CMR & chronische Toxizität (CMR & chron. Tox.)	Gefährdung Oberflächen gewässer (Aq. Tox. akut)	Gefährdung Oberflächen gewässer (Aq. Tox. chronisch)
Brodifacoum	56073-10-0	harm. C&L; RAR	H300, H310, H330	-	?	H372 (blood), H360D	H400 (M10)	H410 (M10)

FIGURE 4: CLASSIFICATIONS AND ABC CATEGORIZATION OF BRODIFACOUM

<u>aquatic toxicity; PBT & vPvB criteria; Environmental performance</u>

The classification with H410 and a multiplication factor of 10 shows a considerable chronic aquatic toxicity: Brodifacoum is not easily degradable, the NOEC value for algae is 0.01 mg/l. Brodifacoum is (very) bioaccumulative and persistent and, together with the classification as toxic to reproduction, meets the PBT criteria.

TABLE 12: PERSISTENCE, BIOACCUMULATION POTENTIAL AND TOXICITY OF BRODIFACOUM.

	P	Vp	B	Vb	T
Measurement variable	DT50 (floor)		BCF		CMR; STOT RE; NOEC (aq.)
Criterion	> 120 days	> 180 days	> 2000	> 5000	
Brodifacoum	157 days		BCF: 15820 (earthworm); 35645 (Fish)		H360 D
Assessment	P	-	-	Vb	R

<u>Exclusion criteria, requirements for (product) approval</u>

The active substance is persistent, bioaccumulative and toxic to reproduction and thus meets the exclusion criteria of Article 5(1)(a) and (e) of the Biocidal Products Regulation. It is therefore also a candidate for substitution. According to the opinion of the BPC [19], there are no known resistances to brodifacoum. The opinion notes that slow-acting anticoagulant rodenticides such as brodifacoum

cause pain in rodents for several days and are generally not considered a humane method of controlling rodents. Alternatives would be other active ingredients or biocidal products and non-chemical control methods. However, as there are concerns as to whether known alternatives are sufficiently effective or have other practical or economic drawbacks, anticoagulant rodenticides containing biocidal products are accepted and brodifacoum is authorised under Article 5(2). Theopinion specifies specifications and restrictions for product approval, including the limitation of the active ingredient content in the product to a maximum of 50 mg/kg, only use as ready-to-use finished products (no powder) and no accessibility for children when used indoors. Exposure of humans, non-target animals and the environment should be minimised and risk reduction measures should be applied. This includes the restriction to professional or trained users.

Application, market relevance: Brodifacoum is approved in 567 products according to the ECHA database, in the Austrian Biocidal Products Directory there are 103 product entries [14], [19].

Difethialon (CAS 104653-34-1)

For the approved active substance, there is an active ingredient report, an opinion of the BPC, a harmonised classification and a RAC opinion. Difethialone is classified as H300, H310 and H330 ("danger to life in the event of: ingestion, skin contact and inhalation"), for which the following LD50 values are reported [21], [22].

TABLE 13: LD50 VALUES OF DIFETHIALON

	oral (mg/kg bw)	Dermal (mg/kg bw)	Inhalation (mg/l)
LD50 (Rat)	0,4	6,5	0,01

Difethialone is classified as chronically toxic (target organ: blood) and toxic to fertility (H360D) with H372. A corrosive, skin-sensitizing, mutagenic and carcinogenic hazard is excluded in the RAC Opinion.

Stoffbezeichnung	CAS Nummer	Datenquelle(n) für ABC Kategorisierung	Akute Giftigkeit (Akut Tox.)	Reiz-, Ätzwirkung (Korr.)	Sensibilisierung (Sens.)	CMR & chronische Toxizität (CMR & chron. Tox.)	Gefährdung Oberflächen gewässer (Aq. Tox. akut)	Gefährdung Oberflächen gewässer (Aq. Tox. chronisch)
Difethialone	104653-34-1	harm. C&L (RAC-Op.); RAR	H300, H310, H330, EUH070	-	-	**H372 (blood), H360D**	H400 (M100)	**H410 (M100)**

FIGURE 5: CLASSIFICATIONS AND ABC CATEGORIZATION OF DIFETHIALON

aquatic toxicity; PBT & vPvB criteria; Environmental performance

The classification with H410 and multiplication factor 100 indicates a very high aquatic toxicity: difethialone is not easily degradable, the EC value for daphnia is 0.004 mg/l. Thus, the RAC classifies acute water toxicity with H400 (M100) and – due to a lack of data – chronic water toxicity by analogy with H410 (M100). Difethialone is highly bioaccumulative and very persistent and, together with the classification as toxic for reproduction (H360 D), meets both the vPvB and PBT criteria.

TABLE 14: PERSISTENCE (P), BIOACCUMULATION POTENTIAL AND TOXICITY OF DIFETHIALONE

	P	Vp	B	Vb	T
Measurement variable	DT50 (floor)		BCF		CMR; STOT RE; NOEC (aq.)
Criterion	> 120 days	> 180 days	> 2000	> 5000	
Difethialon	635 days		BCF (calculated): 39,974; 14.000		H360 D
Assessment	-	Vp	-	Vb	R

Exclusion criteria, requirements for (product) approval

The active substance fulfils the exclusion criteria of Article 5(1)(a) and (e) of the Biocidal Products Regulation and is also a candidate for substitution. According to the opinion of the BPC [21], no resistances are known. The product should only be used by trained professional users as a ready-to-use finished product (no powder).

Application, market relevance: Difethialon is approved in 23 products according to the ECHA database. In the Austrian Biocidal Products Directory there are 17 product entries that are limited to professional use [14], [21].

Flocoumafen (CAS 90035-08-8)

For the approved active substance, there is an active ingredient report, an opinion of the BPC, a harmonised classification and a RAC opinion. Flocoumafen is classified as H300, H310 and H330 ("danger to life if: ingestion, skin contact and inhalation") [23], [24].

TABLE 15: LD50 VALUES OF FLOCOUMAFEN

	oral (mg/kg bw)	Dermal (mg/kg bw)	Inhalation (mg/l/4h)
LD50 (Rat)	0,37	0,87	0,0008

The active ingredient is chronically toxic with H372 (target organ: blood). A review of the evidence led (according to the RAC opinion) to the conclusion that flocoumafen negatively affects the development of the embryo in the uterus and is classified as toxic to fetus with H360D. Classification with H410 and a multiplication factor of 10 indicates significant aquatic toxicity. A corrosive, sensitizing, mutagenic or carcinogenic hazard is not to be assumed.

Stoffbezeichnung	CAS Nummer	Datenquelle(n) für ABC Kategorisierung	Akute Giftigkeit (Akut Tox.)	Reiz-, Ätzwirkung (Korr.)	Sensibilisierung (Sens.)	CMR & chronische Toxizität (CMR & chron. Tox.)	Gefährdung Oberflächen gewässer (Aq. Tox. akut)	Gefährdung Oberflächen gewässer (Aq. Tox. chronisch)
Flocoumafen	90035-08-8	harm. C&L (RAC Op.)	H300, H310, H330	-	-	H372 (blood), H360D	H400 (M10)	H410 (M10)

FIGURE 6: CLASSIFICATIONS AND ABC CATEGORIZATION OF FLOCOUMAFENS

aquatic toxicity; PBT & vPvB criteria; Environmental performance

The classification with H410 and multiplication factor 10 shows considerable aquatic toxicity. Flocoumafen is not easily degradable, the EC50 value for daphnia is 0.07 mg/l. The RAC classifies acute water toxicity as H400 (M10) and – due to a lack of data – chronic water toxicity by analogy with H410 (M10). Flocoumafen is highly bioaccumulative and very persistent and, together with the classification as toxic for reproduction (H360 D), meets both the vPvB and PBT criteria.

TABLE 16: PERSISTENCE, BIOACCUMULATION POTENTIAL AND TOXICITY OF FLOCOUMAFEN

	P	Vp	B	Vb	T
Measurement variable	DT50 (floor)		BCF		CMR; STOT RE; NOEC (aq.)
Criterion	> 120 days	> 180 days	> 2000	> 5000	
Flocoumafen	213 days		BCF (fish): 24300		H360 D
Assessment	-	Vp	-	Vb	R

Exclusion criteria, requirements for (product) approval

The active substance is (very) persistent, (very) bioaccumulative and toxic for reproduction and thus fulfils the exclusion criteria Article 5(1)(a) and (e) of the Biocidal Products Regulation and is also a candidate for substitution. According to the opinion of the BPC [23], there is no known resistance to flocoumafen or the active ingredient is relevant in the occurrence of resistance. The opinion notes

that slow-acting anticoagulant rodenticides such as brodifacoum cause pain in rodents for several days and are generally not considered a humane method of controlling rodents. Alternatives would be other active ingredients or biocidal products and non-chemical control methods. However, as there are concerns as to whether known alternatives are sufficiently effective or have other practical or economic drawbacks, anticoagulant rodenticides containing biocidal products are accepted and brodifacoum is authorised under Article 5(2). The opinion specifies risk minimisation measures, including limiting the active ingredient content in the product to a maximum of 50 mg/kg. The product should only be used by trained professional users as a ready-to-use finished product (no powder).

Application, market relevance

Flocoumafen is approved in 7 products according to the ECHA database. In the Austrian Biocidal Products Directory there are 10 product entries that are limited to professional use [14], [23].

Bromadiolone (CAS 28772-56-7)

Data sources for the approved active substance are an active substance report, an opinion of the BPC, a harmonised classification and a RAC opinion. Bromadiolone is classified as H300, H310 and H330 ("danger to life in the event of: ingestion, skin contact and inhalation") [25] [26].

TABLE 17: LD50 VALUES OF BROMADIOLONE

	oral (mg/kg bw)	Dermal (mg/kg bw)	Inhalation (mg/l/4h)
LD50 (Rat)	0,56	23,31	0,00043

The active ingredient is chronically toxic (H372; target organ: blood) and toxic to fertility (H360D). There is no evidence of a corrosive, skin-sensitizing, mutagenic or carcinogenic hazard.

Stoffbezeichnung	CAS Nummer	Datenquelle(n) für ABC Kategorisierung	Akute Giftigkeit (Akut Tox.)	Reiz-, Ätzwirkung (Korr.)	Sensibilisierung (Sens.)	CMR & chronische Toxizität (CMR & chron. Tox.)	Gefährdung Oberflächen gewässer (Aq. Tox. akut)	Gefährdung Oberflächen gewässer (Aq. Tox. chronisch)
Bromadiolone	28772-56-7	harm. C&L; RAC Op.; BPC-Op.	H300, H310, H330	-	-	**H372 (blood), H360D**	H400 (M1)	H410 (M1)

FIGURE 7: CLASSIFICATIONS AND ABC CATEGORIZATION OF BROMADIOLONE

aquatic toxicity; PBT & vPvB criteria; Environmental performance

The active ingredient is not easily degradable, the EC50 value for algae is 0.04 mg/l. Bromadiolone is assessed as bioaccumulative and persistent and, together with the classification as toxic to reproduction (H360 D), meets the PBT criteria.

TABLE 18: PERSISTENCE, BIOACCUMULATION POTENTIAL AND TOXICITY OF BROMADIOLONE

	P	Vp	B	Vb	T
Measurement variable	DT50 (floor)		BCF		CMR; STOT RE; NOEC (aq.)
Criterion	> 120 days	> 180 days	> 2000	> 5000	
Bromadiolone	>120 days		Analogy to Difenacoum		H360 D
Assessment	P	-	B	-	R

Exclusion criteria, requirements for (product) approval

The active substance fulfils the exclusion criteria of the Biocidal Products Regulation and is a candidate for substitution. According to the opinion of the BPC [25], slow-acting anticoagulant rodenticides in rodents are not to be regarded as a humane control method. However, as there are concerns as to whether alternatives are sufficiently effective or have other practical or economic disadvantages, anticoagulant rodenticides are authorised under Article 5(2). In the opinion , the active ingredient content in the ready-to-use finished product (no powder) is limited to a maximum of 50 mg/kg, the product is only to be used by trained professional users.

Application, market relevance

Bromadiolone is approved in 552 products according to the ECHA database. in the Austrian Biocidal Products Directory there are 63 product entries [14], [25].

Difenacoum (CAS 56073-07-5)

Data sources for the approved active substance are an active substance report, an opinion of the BPC, a harmonised classification and a RAC opinion. Difenacoum is classified as H300, H310 and H330 ("danger to life in the event of ingestion, skin contact and inhalation") [27], [28].

TABLE 19: LD_{50} VALUES OF DIFENACOUM

	oral (mg/kg bw)	Dermal (mg/kg bw)	Inhalation (mg/l/4h)
LD50 (Rat)	1,8	≤ 50	0,004

The active ingredient is chronically toxic (H372; target organ: blood) and toxic to fertility (H360D). There is no evidence of a corrosive, skin-sensitizing, mutagenic or carcinogenic hazard.

Stoffbezeichnung	CAS Nummer	Datenquelle(n) für ABC Kategorisierung	Akute Giftigkeit (Akut Tox.)	Reiz-, Ätzwirkung (Korr.)	Sensibilisierung (Sens.)	CMR & chronische Toxizität (CMR & chron. Tox.)	Gefährdung Oberflächen gewässer (Aq. Tox. akut)	Gefährdung Oberflächen gewässer (Aq. Tox. chronisch)
Difenacoum	56073-07-5	harm. C&L; RAR	H300, H310, H330	-	-	**H372 (blood), H360D**	H400 (M10)	H410 (M10)

FIGURE 8: CLASSIFICATIONS AND ABC CATEGORIZATION OF DIFENACOUM

aquatic toxicity; PBT & vPvB criteria; Environmental performance

Difenacoum is not easily degradable, the acute LC50 value for fish is 0.064 mg/l. The RAC classifies acute water toxicity as H400 (M10) and – due to a lack of data – chronic water toxicity by analogy with H410 (M10). Difenacoum is bioaccumulative and (very) persistent and fulfils the PBT criteria with the classification as toxic for reproduction (H360 D).

TABLE 20: PERSISTENCE, BIOACCUMULATION POTENTIAL AND TOXICITY OF DIFENACOUM

	P	Vp	B	Vb	T
Measurement variable	DT50 (floor)		BCF		CMR; STOT RE; NOEC (aq.)
Criterion	> 120 days	> 180 days	> 2000	> 5000	
Difenacoum	439 days		1100		H360 D
Assessment	-	Vp	B	-	R

Exclusion criteria, requirements for (product) approval

The active substance fulfils the exclusion criteria of the Biocidal Products Regulation and is a candidate for substitution. According to the opinion of the BPC [27], in some areas of Europe, house mice as well as rats are resistant to Difenacoum. Slow-acting anticoagulant rodenticides in rodents are not to be considered as a humane method of control. However, as there are concerns as to whether alternatives are sufficiently effective or have other practical or economic drawbacks, anticoagulant rodenticides are accepted and authorised under Article 5(2). In the opinion , the active ingredient content in the (finished) product is limited to a maximum of 75 mg/kg, which must be used by professional users.

Application, market relevance

Difenacoum is approved in 502 products according to the ECHA database. in the Austrian Biocidal Products Directory there are 57 product entries [14], [27].

alpha-bromadiolone

Approval for the active ingredient is ongoing. There is a proposal for a harmonized classification in the Registry for CHL Intention. According to the study, alpha-bromadiolone is acutely toxic with H300, H310 and H330 ("danger to life in the event of: ingestion, skin contact and inhalation"), chronically toxic (H372) and toxic to fertility (H360D) [29], [30].

Stoffbezeichnung	CAS Nummer	Datenquelle(n) für ABC Kategorisierung	Akute Giftigkeit (Akut Tox.)	Reiz-, Ätzwirkung (Korr.)	Sensibilisierung (Sens.)	CMR & chronische Toxizität (CMR & chron. Tox.)	Gefährdung Oberflächen gewässer (Aq. Tox. akut)	Gefährdung Oberflächen gewässer (Aq. Tox. chronisch)
alpha-bromadiolone	-	harm. C&L (Vorschlag)	H300, H310, H330	?	?	**H372, H30D**	?	H412

FIGURE 9: CLASSIFICATIONS AND ABC CATEGORIZATION OF ALPHA-BROMADIOLONE

aquatic toxicity; PBT & vPvB criteria; Environmental performance

The proposal for a harmonised classification provides for a classification of H412 ('harmful to aquatic organisms, with long-term effects'), which implies low aquatic toxicity. Data on degradability, persistence or bioaccumulation are not available.

TABLE 21: PERSISTENCE, BIOACCUMULATION POTENTIAL AND TOXICITY OF ALPHA - BROMADIOLONE

	P	Vp	B	Vb	T
Measurement variable	DT50 (floor)		BCF		CMR; STOT RE; NOEC (aq.)
Criterion	> 120 days	> 180 days	> 2000	> 5000	
alpha-bromadiolone	No information		No information		H360 D
Assessment	?	?	?	?	R

Exclusion criteria, requirements for (product) approval

Since H360 D (toxic for reproduction) is proposed for the active substance, it can be assumed that it fulfils the exclusion criteria under Article 5(1)(c) of the Biocidal Products Regulation and is also a candidate for substitution. Approval can be assumed because the other SGAR active ingredients are also approved with the same risk.

Application, market relevance

The following explanation of the motivation for the approval of alpha-bromadiolone can be found in the literature [2]: "*One strategy for optimising the potency and environmental properties of rodenticides is the use of pure enantiomers as far as chiral substances are concerned. This has the advantage that active substances already approved as rodenticides, including 2nd generation anticoagulants, can be considered for this strategy. This would minimise the approval effort, as a large number of existing data could possibly be transferred to the enantiomerically pure substances. This approach is currently being pursued, for example, with alpha-bromadiolone, which is currently in the process of being approved as a biocidal active ingredient. It contains ≥76.9% of the cis diastereomeric pair and accordingly has a lower excretion half-life in rats. The improved properties are due to the fact that most of the enzymes that are influenced by the active ingredients are also chiral and can therefore interact better with some enantiomers and/or diastereomers of an active ingredient than with others*."

There are currently no products available on the market with alpha-bromadiolone as an active ingredient.

ACTIVE INGREDIENTS VIA THE GAS PHASE

Phosphine-Releasing Aluminum Phosphide (CAS 20859-73-8)

For the approved active substance, there is an active ingredient report for PT14, a harmonised classification and a RAC opinion. The latter is limited to the classification of the acute toxic effect. Aluminium phosphide is classified as H300 or H330 ("danger to life if swallowed or inhaled"), H311 ("toxic in contact with skin"), EUH029 ("emits toxic gases in contact with water") and EUH032 ("emits very toxic gases in contact with acid") [31], [32].

Stoffbezeichnung	Akute Giftigkeit (Akut Tox.)	Reiz-, Ätzwirkung (Korr.)	Sensibilisierung (Sens.)	CMR & chronische Toxizität (CMR &	Gefährdung Oberflächen gewässer (Aq. Tox.	Gefährdung Oberflächen gewässer (Aq. Tox. chronisch)
Phosphin freisetzendes Aluminiumphosphid	EUH029, EUH032, H300, H311, H330	?	?	?	H400 (M100)	?

FIGURE 10: CLASSIFICATIONS AND ABC CATEGORIZATION OF ALUMINUM PHOSPHIDE

The actual active ingredient phosphine (7803-51-2), which is released by moisture during application, is harmonized with H314 ("Causes severe skin burns and severe eye damage"), H330 ("Danger to life if inhaled") and H400 ("Very toxic to aquatic organisms").

aquatic toxicity; PBT & vPvB criteria; Environmental performance

Aluminium phosphide has a significant acute aquatic toxicity with a classification of H400 and a multiplication factor of 100. In water, aluminum phosphide decomposes into phosphine and aluminum hydroxide. According to the active ingredient report, the half-life (DT50) of the decay of phosphine is 4 to 5 days, the calculated BCF is 1.16 and 0.94 respectively. On the basis of these data, the PBT criterion does not apply.

Exclusion criteria, requirements for (product) approval

There is no opinion of the BPC on the authorisation in the ECHA database. On the basis of the known properties, it can be assumed that the exclusion criteria according to Art. 5 Biocidal Products Regulation do not apply to the active substance.

Application, market relevance

The active substance report [31] describes the application and efficacy as follows: The product, which contains the active ingredient aluminium phosphide, is intended for the control of rodent species outdoors for all types of non-agricultural purposes, including dams and dikes. Aluminum phosphide products are only laid out in cave systems by trained professionals who are familiar with the precautions to be applied. The active ingredient aluminium phosphide reacts with moisture in the soil and in the air and releases the toxic gas phosphine. 100% efficacy has been achieved against rats, but only in sites with low or medium infestation. The effectiveness in controlling rats in sites with high infestation was not satisfactory. It seems difficult to eradicate the rats in places where the burrows are connected to other devices that allow them to escape from the treated burrow. Resistance to aluminium phosphide did not occur in relevant susceptible pests.

Aluminium phosphide is approved in 10 products according to the ECHA database, there are no product entries in the Austrian Biocidal Products Directory [14], [31].

Hydrogen cyanide (CAS 74-90-8)

The approved active ingredient is accompanied by an active substance report, a REACH dossier and a harmonised classification. The latter distinguishes between the active ingredient solution and the (gaseous) active ingredient. Hydrogen cyanide is classified as H330 ("danger to life in the event of ingestion, skin contact and inhalation") in all sources. The REACH dossier classifies hydrogen cyanide as chronically toxic H372 (target organ: thyroid gland), but there is a lack of data for an assessment of the corrosive and skin sensitizing effect. A carcinogenic, mutagenic or reprotoxic hazard is not assumed in the REACH dossier [33], [34].

Stoffbezeichnung	Akute Giftigkeit (Akut Tox.)	Reiz-, Ätzwirkung (Korr.)	Sensibilisierung (Sens.)	CMR & chronische Toxizität (CMR & chron. Tox.)	Gefährdung Oberflächen gewässer (Aq. Tox.	Gefährdung Oberflächen gewässer (Aq. Tox. chronisch)
Cyanwasserstoff	H300, H310, H330	?	?	**H372 (Schilddrüse)**	H400 (M?)	H410 (M?)

FIGURE 11: CLASSIFICATIONS AND ABC CATEGORIZATION OF HYDROGEN CYANIDE

aquatic toxicity; PBT & vPvB criteria; Environmental performance

The active substance report [33] states that hydrogen cyanide does not have properties of PBT or vPvB due to its preferred retention capacity in the free atmosphere, its low bioaccumulation capacity, and its low persistence from the point of view of the definition values of these parameters.

Exclusion criteria, requirements for (product) approval

There is no opinion of the BPC on the authorisation in the ECHA database. On the basis of its properties, it can be assumed that the active ingredient does not meet any exclusion criteria according to Art. 5 Biocidal Products Regulation. For the product BLUEFUME, which is approved in Austria, there is a letter of approval with corresponding conditions [35]

Application, market relevance

The active substance report [33] states that hydrogen cyanide as a fumigant for professional use only for the control of pests of the main group 03 - PT 14 is used only in empty warehouses, warehouses, transport facilities, containers, libraries, other buildings without any materials used in the are able to absorb hydrogen cyanide and which cannot be made strictly gas-tight. Prussic acid must never be used in buildings that are inhabited by people. Target organisms are rodents: Rattus norvegicus, Rattus rattus, Mus musculus, Microtus arvalis. The universal effectiveness against rodents results from the well-known mechanism of toxic action. This is confirmed by many years of experience as well as by acute toxicity studies. Experience shows that target organisms do not develop resistance.

Hydrogen cyanide is approved in 1 product according to the ECHA database , in the Austrian Biocidal Products Directory there is 1 product entry [14], [33].

Carbon dioxide (CAS 124-38-9)

Carbon dioxide is no longer approved as a rodenticidal active ingredient. At the time of the query, a report from 2007 was available for the biocidal active substance , which states that there is an extensive database with information on carbon dioxide. No critical endpoints were identified for carbon dioxide in terms of adverse health and environmental impacts [36], [37].

Stoffbezeichnung	Akute Giftigkeit (Akut Tox.)	Reiz-, Ätzwirkung (Korr.)	Sensibilisierung (Sens.)	CMR & chronische Toxizität (CMR & chron. Tox.)	Gefährdung Oberflächen gewässer (Aq. Tox. akut)	Gefährdung Oberflächen gewässer (Aq. Tox. chronisch)
Kohlendioxid	-	-	-	-	-	-

FIGURE 12: CLASSIFICATIONS AND ABC CATEGORIZATION OF CARBON DIOXIDE

aquatic toxicity; PBT & vPvB criteria; Environmental performance

Toxicity to aquatic organisms and PBT criteria cannot be assumed due to the lack of critical endpoints (no classifications regarding aquatic toxicity) and the natural occurrence of carbon dioxide.

Exclusion criteria, requirements for (product) approval

There is no opinion of the BPC on the authorisation in the ECHA database for product type 14. On the basis of the known properties, it can be assumed that the exclusion criteria according to Art. 5 Biocidal Products Regulation do not apply to the active substance.

Application, market relevance

The use of carbon dioxide as a rodenticide is approved in several EU countries – including Austria – with the trade names Ekomille CO2 and RADAR. According to the (Austrian) approval notice, Ekomille CO2 is a pressure-tight gas cylinder connected to a safety gear as an accompanying method for the control of domestic rats [38]. The rodents are attracted to food and get into the device, where they are caught and fall into a compartment partially filled with liquid. At the same time, carbon dioxide is released from the gas cylinder into the compartment. The rodents lose consciousness by inhaling the carbon dioxide. The product may only be handled by a licensed pest controller. RADAR is a trap in combination with a gas cylinder, in which case the house mouse is the target organism.

OTHER ACTIVE INGREDIENTS

Cholecalciferol (Vitamin D3) (CAS 67-97-0)

For the approved active substance, there is an active ingredient report, an opinion of the BPC, a harmonised classification and a RAC opinion. Cholecalciferol is harmonized with H300, H310 and H330 ("danger to life in the event of: ingestion, skin contact, inhalation") and is also chronically toxic (H372). A corrosive, skin-sensitizing, mutagenic, reprotoxic and carcinogenic hazard is not to be assumed [39], [40].

Stoffbezeichnung	CAS Nummer	Datenquelle(n) für ABC Kategorisierung	Akute Giftigkeit (Akut Tox.)	Reiz-, Ätzwirkung (Korr.)	Sensibilisierung (Sens.)	CMR & chronische Toxizität (CMR & chron. Tox.)	Gefährdung Oberflächen gewässer (Aq. Tox. akut)	Gefährdung Oberflächen gewässer (Aq. Tox. chronisch)
Colecalciferol / Cholecalciferol (Vitamin D3)	67-97-0	harm. C&L; RAR;RAC-Op.	H300, H310, H330	-	-	H372 (all routes)	-	-

FIGURE 13: CLASSIFICATIONS AND ABC CATEGORIZATION OF CHOLECALCIFEROL

aquatic toxicity; PBT & vPvB criteria; Environmental performance

According to the current opinion of the BPC

- according to the active ingredient report, a risk to the aquatic environment is not to be assumed, and cholecalciferol also does not meet the PBT criteria,
- A risk characterization was carried out for the terrestrial compartment with regard to the exposure of cholecalciferol to organisms via contaminated soils, directly through the consumption (consumption) of the product (primary poisoning) and indirectly via the terrestrial food chain (secondary poisoning). It is expected that the risk to soil organisms is acceptable,
- A qualitative assessment of acute primary poisoning as well as acute secondary poisoning by bait (primary) and poisoned rodents (secondary) showed that the estimated exposure to non-target animals in birds is well below the LD_{50} value, while the estimated exposure in mammals is in the same range as in LD_{50}. It is therefore unlikely that birds will die from acute primary or secondary poisoning.

A quantitative risk assessment was carried out for long-term primary poisoning and secondary poisoning by poisoned rodents as well as secondary poisoning by earthworms. This assessment found unacceptable risks, with the exception of birds that eat earthworms; For the latter scenario, the risk was acceptable. The unacceptable risks for birds and mammals are the result of disruption of the endocrine system. A long-term primary or secondary risk of poisoning for birds and mammals cannot be ruled out if it is assumed that their diet consists largely of rodenticide bait or poisoned rodents.

Unacceptable application risks were identified for the following scenarios:

- Mammal (weasel): eats bait / eats poisoned rodent / ingests food consisting mainly of rodent bait or poisoned rodents / food source is earthworms that live in contaminated soil.
- Birds (barn owl): food consisting mainly of rodent bait or poisoned rodents

Cholecalciferol causes hypercalcemia in toxic doses. Such an effect is also relevant in humans. However, there is a negligible risk from human exposure. There is a physiological concentration range that is well tolerated by humans and the exposure resulting from this biocidal use is not expected to contribute significantly to vitamin D exposure through the intake of foods and supplements.

Exclusion criteria, requirements for (product) approval

The BPC's 2024 opinion states that cholecalciferol is a prohormone and meets the exclusion criteria set out in Article 5. The overall conclusion of the BPC is that cholecalciferol should not normally be approved due to its endocrine properties and that such a regulation is therefore an exemption. In the event of product approval, the regulatory authority of the active ingredient specifies restrictions on the use and the group of persons to be used in the RAC Opinion [40].

Application, market relevance

Cholecaliferol is approved in the EU in 3 commercial products under different names: Habitro; Harmonix; Replexa; Selontra; Racumin. In Austria, 3 commercial products are approved for use: Selontra, Relpexa, Harmonix Rodent Paste [14], [39].

Alpha-chloralose (CAS 15879-93-3)

There is an active ingredient report from 2008 on the approved active ingredient . The active ingredient is harmonised and is currently being tested for endocrine efficacy, according to the ECHA Infocard. A corrosive and skin-sensitizing hazard as well as CMR effects are excluded in the active ingredient report [41], [42].

Stoffbezeichnung	Akute Giftigkeit (Akut Tox.)	Reiz-, Ätzwirkung (Korr.)	Sensibilisierung (Sens.)	CMR & chronische Toxizität (CMR & chron. Tox.)	Gefährdung Oberflächen gewässer (Aq. Tox. akut)	Gefährdung Oberflächen gewässer (Aq. Tox. chronisch)
alpha-Chloralose	H301, H332, H336	-	-	?	H400 (M10)	H410 (M10)

FIGURE 14: CLASSIFICATIONS AND ABC CATEGORIZATION OF ALPHA-CHOLRALOSIS

aquatic toxicity; PBT & vPvB criteria; Environmental performance

According to the active substance report, alpha-chloralose can be considered potentially persistent (P) or very persistent (vP) in the marine environment. However, due to its low K_{ow} value, it is not considered to meet the criterion of bioaccumulation (B). The T criterion is fulfilled due to the classification as very toxic to aquatic organisms and with the risk of serious damage to health in the event of prolonged exposure.

Exclusion criteria, requirements for (product) approval

The active ingredient meets two of the three PBT criteria. On the other hand, compared to all other rodenticides, the mode of action is significantly more animal welfare-friendly as a narcotic and overall better environmental properties than that of SGAR [2].

Application, market relevance

Alpha-chloralose is currently approved as a biocide for the control of mice indoors. The effect is based on the fact that the animals become unconscious and then die from freezing to death. This limits the effectiveness to temperatures below 15°C, which in turn limits the scope of application. Animal poisoning with alpha-chloralose has been reported in the EU. This may be related to the restriction of anticoagulant rodenticides. Chloralose products may therefore have been increasingly used in the control of mice by the public. In addition to the limited scope of application, the lack of target specificity is also cited as a disadvantageous property of alpha-chloralose. In addition, a reduced acceptance of the bait due to the taste was found, which was tried to circumvent by microencapsulation [2].

Alpha-chloralose is approved in 113 products in the EU, and there are 24 product entries in the Austrian Biocidal Products Directory [14], [41].

Corn on the cob, powdered (*engl.* powdered corn cob)

Corn cob powdered is no longer approved as a rodenticidal active ingredient.

The ECHA database does not show any classifications. The active substance report excludes risks to human health - this concerns acute toxicity, irritating properties, CMR properties and chronic toxicity - or assumes them to be negligible. In addition, there are no documents in the ECHA database that evaluate or classify the active substance [43], [44].

Stoffbezeichnung	Akute Giftigkeit (Akut Tox.)	Reiz-, Ätzwirkung (Korr.)	Sensibilisierung (Sens.)	CMR & chronische Toxizität (CMR & chron. Tox.)	Gefährdung Oberflächen gewässer (Aq. Tox. akut)	Gefährdung Oberflächen gewässer (Aq. Tox. chronisch)
Maiskolben, pulverisiert	-	-	-	-	-	-

FIGURE 15: CLASSIFICATIONS AND ABC CATEGORIZATION OF POWDERED CORN COBS

aquatic toxicity; PBT & vPvB criteria; Environmental performance

According to the active ingredient report, corn cob powder does not meet the PBT criteria. Powdered corn cobs are made of plant material, they do not act as a chemical and are divided between aqueous phases and organic surfaces of soils, sediments and sludge. In the environment, the cobs mainly decompose into sugars, which are easily absorbed in the environment .

Exclusion criteria, requirements for (product) approval

No information is available on this

Application, market relevance

There are no products for the active ingredient in the ECHA database or in the Austrian Biocidal Products Directory [14], [43].

ALTERNATIVES TO ANTICOAGULANTS

The most commonly used and widely used rodenticidal agents are anticoagulants (anticoagulants). A distinction is made between those of the first generation (First Generation Anticoagulant Rodenticides, FGAR) and the second generation (Second Generation Anticoagulant Rodenticides, SGAR). First-generation anticoagulants are chlorphacinone, coumatetralyl and warfarin (no longer approved). These usually have to be ingested several times by rats for a lethal effect to occur. Conversely, this creates the risk that rats will get used to a non-lethal poison intake and develop resistance to the active ingredient. To avoid this, the second-generation anticoagulants Brodifacoum, Bromadiolone, Difenacoum, Difethialone and Flocoumafen were developed. These are more toxic than FGAR agents and usually a single bait intake is sufficient to achieve a lethal effect and exclude offspring[2]. This avoids the development of resistance as far as possible.

Unfortunately, risk-minimising requirements imposed by the legislator so far have not yet been able to prevent residues of SGARs from being found widely in wild non-target animals and the environment. The first evidence of rodenticide residues has been documented since the 1990s in barn owls, buzzards, polecats and weasels. Seed- and grain-eating birds are also affected, provided that they eat the bait – which often consists of grain – directly. The percentage of animals examined in the studies that had residues of anticoagulants varies between 10% and 97% [1]. Residues of anticoagulants are analyzed mainly in the liver. It is often not possible to make a concrete statement about whether the measured concentrations were directly fatal or the cause of death. However, it can be assumed that the concentrations detected have been fatal for the animals in some cases. Apart from lethal effects, long-term effects on animal behaviour and reproduction can be assumed due to the high potential of SGARs to accumulate in the food chain. The aquatic ecosystem is also affected: In a German study from 2015, at least 1 second-generation anticoagulant was detected in all liver samples of fish taken from 16 flowing waters. The use of anticoagulant rodenticides in the sewer system is assumed to be a possible source of input [1].

A monitoring by the Federal Environment Agency published in 2020 also confirms this finding for Austria. Foxes, birds of prey (owls) and fish served as indicators of the burden on the terrestrial and aquatic ecosystem. Anticoagulants were detected in 66% of all terrestrial liver samples: The SGAR active ingredients brodifacoum and bromadiolone had the highest concentrations in foxes, followed by difethialone and difenacoum. In owls, the most frequently measured active ingredient was brodifacoum. The concentrations found in the liver were in about 30% of birds and 16% of foxes in a range where negative effects on the living being are possible. Finally, brodifacoum, bromadiolone and warfarin were detected in total fish at three sampling sites on the Inn, Drava and Danube [3].

Findings from different countries and over a long period of time have shown a consistently significant burden of anticoagulant rodenticides on the ecosystem to date. It can therefore be concluded that the risk mitigation measures implemented in the EU active ingredient approval and the national product approvals based on it cannot prevent the spread of SGARs in the environment. Taken together, it can be seen that although anticoagulants are very detrimental to the environment, they dominate the market for rodenticides, as material alternatives – possibly with the exception of alpha-chloralose – are limited to niche applications.

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[2] Within the SGAR active ingredients , difethialone, brodifacoum and flocoumafen are considered to be more effective than bromadiolone and difenacoum respectively.

A concept study has dealt with the question of whether more environmentally friendly rodenticides can be developed that do not pose the risk of primary and secondary poisoning [2]. Although the study opens up promising prospects, it can be assumed that alternative active ingredients will not be available in the short and medium term, taking into account the time-consuming and costly approval process.

CHEMICAL ALTERNATIVES

An environmentally friendly chemical alternative to the anticoagulants that have so far been used on a large scale in nature reserves would be invaluable for the increasingly urgent efforts to preserve biodiversity, but approved chemical alternatives cannot be used sensibly or only to a limited extent [2]. A background paper by the German Federal Environment Agency assesses such as follows [1]:

- Alpha-chloralose can also be used by the general public. However, its use is limited to indoor use and is only approved for the control of house mice. The active ingredient is a narcotic, the ingestion of which causes the mice to fall into a coma after eating, cool down at low ambient temperatures and die as a result. Accordingly, it can only be used at low ambient temperatures and is only sufficiently effective on small organisms.
- Powdered corn cob: Studies show that the effectiveness of corn cob is not comparable to that of anticoagulants, mortality rates are significantly lower. The active ingredient is also not (or no longer) approved in the EU.
- Carbon dioxide, hydrogen cyanide and phosphide (from aluminium phosphide) as fumigants may only be used by specially trained specialists and therefore have a limited range of applications. Carbon dioxide is also no longer approved as a rodenticide in the EU.
- Cholecalciferol (commercial product: Selontra) is a relevant chemical alternative to anticoagulants because the active ingredient does not exhibit CMR or PBT properties. The mechanism of action that leads to the death of the target organism is, as with anticoagulants, a delayed one, so that a prolonged suffering of the target organisms cannot be ruled out, as in the case of anticoagulant agents. In addition, there is also a risk of primary and secondary poisoning for mammals and birds. Cholecalciferol shows endocrine activity, which makes it a candidate for substitution under Art. 10.

The concept study of the Federal Environment Agency on the development possibilities of an environmentally compatible rodenticide offers a comparative semi-quantitative point evaluation of approved active substances, which can provide guidance in the selection of rodenticides [2]. It is noteworthy that the aspects of application and environmental impact are included as comprehensively as possible, but the criteria are not weighted in relation to each other (see Table 22 and Figures 16 and 17).

TABLE 22: SUMMARY OF THE CRITERIA AND FAVOURABLE AND UNFAVOURABLE ASSESSMENTS IN [2].

Criteriaa	Rating (rather) cheap or positive	Rating (rather) unfavorable or negative
Toxic effect	Very toxic (1)	Non-toxic (-1)
Physiological resistance	Unknown (0)	Known (-1)
Bait shy	Unlikely (0)	Likely (-1)

Carcinogenic, mutagenic, toxic to reproduction, endocrine action	No effect (1)	Effect (-1)
Aquatic toxicity	Non-hazardous to water (1)	Hazardous to water (-1)
Persistence	Non-persistent (1)	Very persistent (-1)
Risk of accumulation	Non-bioaccumulative (1)	Bioaccumulative (-1)
Risk of primary poisoning, secondary poisoning	Hydrolysis Sensitive Substances (1)	Not known or assumed (-1)
Potential for suffering	Expected low (1)	Not known or high (-1)
Questionable Metabolites	Safe (1)	Questionable (-1)
Applications	Two or more (1)	Less than two (0)
User Category	General public (1)	Trained / Professional (0)

a… the criteria are presented in an overview or in excerpts, a detailed explanation is given [2].

If no information could be determined for a criterion, a value of "0" was assumed – unless otherwise stated – and the corresponding criterion was included in the error bar for consideration.

The assessment shows that the chemical alternatives hydrogen cyanide/hydrogen cyanide, cholecalciferol and alpha-chloralose are generally rated more favourably than the anticoagulants. Within the anticoagulants, coumatetralyl, warfarin and difethialone perform relatively favourably, while difenacoum and bromadiolone perform relatively unfavourably. In the case of brodifacoum, the (very) poor environmental assessment is cancelled out by the good practicability and low costs, and the active ingredient thus ends up in the middle of the field.

Tabelle B1: Aufschlüsselung der Bewertung der FGAR, SGAR und weiterer aktuell eingesetzter Rodentizide.

	Wirkung auf Ratten	Wirkung auf Mäuse	Physiologische Resistenz	Köderscheu/Akute Wirkung	Aquatische Toxizität	Endokrine Wirkung	Karzinogene Wirkung	Mutagene Wirkung	Reproduktionstoxizität	Persistenz	Akkumulationsrisiko	Formulierung als Fraßgift	Wirtschaftlichkeit	Bekannter Mechanismus	Risiko Primärvergiftung	Risiko Sekundärvergiftung	Leidenspotential	Bedenklichkeit Metabolite	Anwendungsgebiete	Verwenderkategorie	Antidot	Gesamtbewertung (inklusive Fehler)
Chlorophacinon (CAS-Nr.: 3691-35-8)	1	1	-1	0	-1			1	-1	-1	1	1	1	1	-1	-1	-1		1	0	1	2 (±3)
Coumatetralyl (CAS-Nr.: 5836-29-3)	0	1	-1	0	-1		1	1	-1	-1	1	1	1	1	-1	-1	-1		1	1	1	3 (±2)
Warfarin (CAS-Nr.: 81-81-2)	1	1	-1	0	-1			1	-1	-1	1	1	1	1	-1	-1	-1		1	1	1	3 (±3)
Brodifacoum (CAS-Nr.: 56073-10-0)	1	1	0	0	-1		1	1	-1	-1	-1	1	1	1	-1	-1	-1		1	0	1	2 (±2)
Bromadiolon (CAS-Nr.: 28772-56-7)	1	1	-1	0	-1			1	-1	-1	-1	1	1	1	-1	-1	-1	-1	1	0	1	-1 (±2)
Difenacoum (CAS-Nr.: 56073-07-5)	1	1	-1	0	-1			1	-1	-1	-1	1	1	1	-1	-1	-1		1	0	1	0 (±3)

FIGURE 16: EVALUATION OF CHLOROPHACINONE, COUMATETRALYL, WARFARIN, BRODIFACOUM, BROMADIOLONE AND DIFENACOUM IN [2].

	Wirkung auf Ratten	Wirkung auf Mäuse	Physiologische Resistenz	Köderscheu/Akute Wirkung	Aquatische Toxizität	Endokrine Wirkung	Karzinogene Wirkung	Mutagene Wirkung	Reproduktionstoxizität	Persistenz	Akkumulationsrisiko	Formulierung als Fraßgift	Wirtschaftlichkeit	Bekannter Mechanismus	Risiko Primärvergiftung	Risiko Sekundärvergiftung	Leidenspotential	Bedenklichkeit Metabolite	Anwendungsgebiete	Verwenderkategorie	Antidot	Gesamtbewertung (inklusive Fehler)
Difethialon (CAS-Nr.: 104653-34-1)	1	1	0	0	-1		1	1	-1	-1	-1	1	1	1	-1	-1	-1	1	1	0	1	3 (±1)
Flocoumafen (CAS-Nr.: 90035-08-8)	1	1	0	0	-1			1	-1	-1	-1	1	1	1	-1	-1	-1	1	1	0	1	2 (±2)
Alphachloralose (CAS-Nr.: 15879-93-3)	1	0	0	-1	-1	1				-1	0	1	1	1	1	-1	1			1	0	4 (+5 -4)
Blausäure (CAS-Nr.: 74-90-8)	1	1	0	-1	-1		1	1	1	1	1	1	1	1	-1	-1	-1	1		0	1	7 (+2 -1)
Cholecalciferol (CAS-Nr.: 67-97-0)	1	1	0	0		-1	1	1	1	1	1	1	1	1	-1	-1	-1	1	1	0	1	9 (±1)
Zinkphosphid (CAS-Nr.: 1314-84-7)	1	1	0	-1	-1		1		1	1	-1	1	1	0	-1	-1	-1	-1		0	0	0 (+3 -2)

FIGURE 17: EVALUATION OF DIFETHIALONE, FLOCOUMAFEN, ALPHACHLORALOSE, HYDROGEN CYANIDE, CHOLECALCIFEROL AND ZINC PHOSPHIDE IN [2].

FALL

Snap traps can be more animal welfare-friendly than poisons if they are designed and used correctly, even if the user may intuitively think the opposite, as it may be more clearly aware and experienced by setting up snap traps that it is about killing animals. However, this is also the case through the application of poisons, except that here the death of the rodents usually takes place in secret. Previous tests indicate that snap traps, when used correctly, can cause less animal suffering when killing rodents than poisoning with anticoagulants. The German UBA is committed to improving the overall quality and justifiability of biocide-free alternatives in the future and to developing test methods and guidelines for their evaluation. However, there is currently no testing or approval body for rodent traps in Germany [1].

With regard to innovations in the field of traps, the following passage can be found in a publication by the German Federal Environment Agency, which is cited as an example [45]: "*At the workshop "Non-Chemical Alternatives for Rodent Control" (NoCheRo) on 20 and 21.11.2019 and a follow-up workshop on 05.02.2020, further indications of trap systems for rodent control were found, which were investigated: The fully automatic rat trap A24 uses a long-lasting, non-toxic permanent bait (24 releases per CO2 capsule) and has a monitoring function (counter). The provider is the IHS – Engineering Office for Hygiene Planning and Pest Prevention in Borgholzhausen. Rentokill offers a patent-protected mouse trap RADAR, which is touted as the world's only approved CO2 biocidal product for mice control (whereby CO2 is to be considered a biocidal product here). The workshop protocol and the guideline for the inspection of rodent traps based on it have now been published.*"

BEST PRACTICE URBAN RAT MANAGEMENT

In practice, it is mainly medium-sized to large cities that have to deal more intensively with the topic of rat management. The control of rats by using anticoagulants and other biocidal agents in bait boxes is an important, but by no means the only measure that is relevant in connection with successful rat management. The following examples of rat management in various European cities illustrate that human resources, the implementation of a central point of contact in the city administration, the intensity of communication with the population, the further administrative options for action, the use of innovative technologies for monitoring, as well as appropriate waste and wastewater management have a significant influence on the existing situation over time. rat population and thus to the required quantities of environmentally harmful rodenticides.

ZURICH

The key points of rat management in Zurich (434,000 inhabitants) explained below are based on an article published in 2024 in the Journal of Pest Control [6] and on a lecture given by Marcus Schmidt at a meeting of the working group "Biocide Reduction in Vienna" on 29 May 2024 [7]. In 2003, Zurich set up its own specialist office for pest prevention with five employees. This office concentrates on combating the causes of pest infestation on public and, if necessary, also on private property. It acts as a central, coordinating reporting office, which immediately checks new cases itself by searching for rat tracks and initiates the necessary measures. Among other things, the agency carries out (demand-based) inspections of public and private property, it initiates hygienic improvements in wastewater and waste management and promotes a reduction in bird and especially pigeon feeding by the population. Rat control with rodenticides and bait boxes is largely carried out by commissioned pest controllers.

In terms of personnel, the city is the only city in Switzerland to have set up the Pest Prevention Unit (SPC), which carries out prevention work and monitoring in particular. 10 – 20% of the work of the reporting office is dedicated to rat control, the team currently consists of 5 people. Each pest report is entered into an online database with its address or GIS data. With the app "Züri wie neu" (Zurich like new), the population can report damage to the urban infrastructure, which also makes it possible to communicate about rat sightings.

Control of public areas

Since 2006, public parks and areas with repeated rat infestations have been checked one to four times a year, thus detecting rat populations at a low level. If necessary, control is carried out. It is now rare for populations of more than ten rats to be found.

Inspections of private property

The city of Zurich takes action when it receives reports of rat sightings from the population and then addresses owners of private properties about the rat problem on their property. In 90% of cases, those responsible hire a pest control company. If they do not act, a written request will be made. If those responsible cannot be determined immediately, bait is carried out by the city itself, or a pest control company is commissioned by the city at the expense of the landowner. If the costs are not paid, the city of Zurich can carry out a "substitute operation" and seize the property. The costs are therefore charged to the property as a kind of mortgage with reference to the canton's Administrative Justice Act. Unlike in Vienna, where the inspection is anchored in the Vienna Rat Ordinance and is therefore

mandatory, there is no general obligation for landowners in Zurich to keep a regular inspection for rat infestation.

Wastewater management

Zurich has about 1,000 km of public sewer lines. Approximately 10 km of this are renewed every year. The sewer system of the old town was completely renewed by 1985. The walk-in sewer system is cleaned at high pressure every two to three years. In addition, the combined sewer system (including rainwater) flushes the sewer system during heavy rainfall. For the most part, it is in very good condition. Bait in the sewer system has not been carried out since 1994.

Waste management

Since 2007, areas of Zurich have been equipped with rat-proof underground containers for waste disposal. The city is largely stocked with rat-proof waste containers. If overcrowded waste containers are reported, efforts are made to improve the situation with the responsible property management companies or homeowners. Public waste bins with integrated rat bait station certificates are practicable as a control measure, which is why a practical trial will be launched from 2024. For this purpose, vandal-proof steel boxes are mounted under the waste bins. Bird feeding is a problem in that rats also benefit from the food supply. Since 2023, feeding wild animals – including that of some bird species such as pigeons or birds of prey – has been banned in the canton of Zurich. Since the police and gamekeepers have little capacity for control, food continues to be spread, albeit somewhat more hidden. In the long term, it is hoped that continuous information of the population will lead to a decline in feeding.

Rodenticides and bait boxes

Six pest control companies are commissioned with both control and prevention work. To combat this, stationary bait boxes with rodenticides are installed on all rat areas. If activity is detected, these are filled with 100 g Racumin paste sachets (Coumatetralyl). At the same time, 30–60 g of Sorkil grains (Difenacoum) are applied directly into the holes of rat burrows with a special shovel. Since 2022, Selontra paste bags (cholecalciferol) have also been used. Brodifacoum is not used because the active ingredient is particularly toxic and should only be a resistance breaker. Cholecalciferol, difenacoum, chlorphacinone and coumatetralyl are used as first-generation anticoagulant agents. Although the number of rat reports has remained more or less stable at 50–70 reports per year since 2007, bait consumption has decreased sharply at about 15 kg of bait per year as well as the number of working hours for control and control, they remain stable at a low level [6]

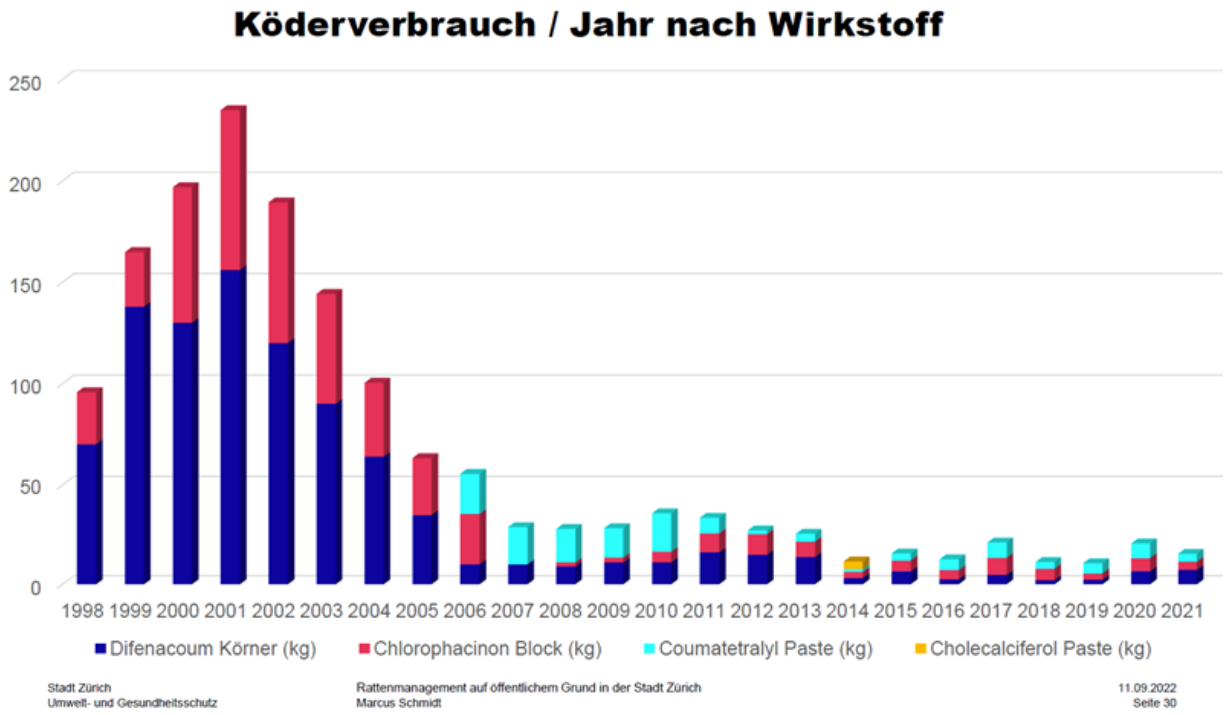

FIGURE 18: BAIT CONSUMPTION OF DIFENACOUM, CHLOROPHACINONE, COUMATETRALYL AND CHOLECALCIFEROL BETWEEN 1998-2021 IN ZURICH [6].

Bait stations are also used by other non-target species such as wood mice, but they disappear when rats appear as they are displaced by them. The stations do not contain grains of interest to small birds, but paste baits. Rodents have to go around the corner to get to the bait, which birds wouldn't do. When using Selontra, there are no problems with secondary poisoning of pets in Zurich. Secondary poisoning only occurs with highly potent anticoagulants such as brodifacoum, but not with Selontra, as the active ingredient cholecalciferol quickly breaks down into non-toxic components. However, care must be taken to deny pets access to the bait to avoid primary poisoning. Therefore, Selontra is not used for direct baiting in rat burrows, as the rat could shovel the bait out of the hole.

BONN

The key points on rat management in Bonn (335,000 inhabitants) explained below are based on the presentation by Mr. Markus Lichtenthäler on the occasion of the working meeting "Biocide Reduction" in Vienna on May 29, 2024 [7] as well as on a telephone interview [unpublished minutes of the conversation]. The cornerstones of the rat management operated by the city are: clarified responsibilities, good networking (e.g. with housing associations, internal offices), awareness raising (multilingual flyer), monitoring & digitization, renovation of the sewer system, targeted placement of bait boxes.

Single point of contact for reports

Mr. Lichtenthäler heads the central contact point for rat management in Bonn and is responsible for rat management in the sewer system, Ms. Katrin Krumbach for above-ground rat management. The new team ensured a convergence of information on rat sightings in the city and standardization of the handling of reports. This contributes a great deal to successful control. For example, rat reports from the population or other offices or the sighting of rats during inspections lead to a needs-based on-site examination, and the report is forwarded to the competent authority in any case. Consultation is held with the reporters, if necessary control on private property may be necessary. Personal conversations with caretakers and other responsible persons at hotspots of rat infestation are also mentioned as of particular importance in order to clarify the causes. A flyer on rat control was created for the population and placed in the mailboxes of residents in areas with rat sightings. This motivates people to call about further sightings, and callbacks serve as further clarification. As a result of the new rat management, rat reports on the surface fell from 5,000 in 2020 to 1000 in 2023.

Rat management in the sewer system and on the surface (public, private)

The control in the sewer system is carried out by city-owned personnel. According to the German Infection Protection Act, the German Infection Protection Act requires the public sector to combat health pests (including rats). This is consistently implemented in the public sector. In the private sector, the health department can only take action and order control if a health hazard can be proven. This has been the case very rarely in Bonn in the last four years (three to four times). Otherwise, the city usually succeeds in asking people to take action through dialogue. Rat control on the surface in Bonn is carried out by private pest controllers commissioned by the public order office or the city order service. In the private sector, citizens are responsible for commissioning themselves, but can also seek advice from the city. The work of rat control in the canal (by the city's own people) has fallen from 30 hours a week to 15 hours a week.

Monitoring, control, rodenticide needs and bait boxes

The control is carried out simultaneously above and below ground and after prior digitised monitoring. This makes it more targeted and efficient, thus reducing the quantities of rodenticides required. In the sewer system, the use of rodenticides has been reduced from 1500 kg to the current 100 kg. If an infestation area is determined on the basis of reports, bait boxes with pure feeding baits (without poisonous effect) are deposited under several manhole covers and observed on which baits bite marks can be found. Only there are poison baits subsequently used. If the infestation is unclear, monitoring baits are first used to identify the rats' routes and to lay out poison baits along these paths.

Once the actual routes of the rats have been investigated, there is initially no control of the cause (garbage situation remains unchanged for the time being), because the rats immediately change their paths when the garbage is removed. This would make it more difficult to control them. Only when the infestation has been sufficiently reduced is the cause controlled. Bait boxes are used for monitoring

and control both in the channel and on the surface, whose rat visit can be read out digitally. To do this, however, you have to drive to the relatively expensive boxes on site. The rat visits are then located by reading the data into a GIS map.

Rat infestation hotspots are now equipped with 60 permanent boxes in the sewer system and 20 on the surface (integrated into garbage cans, especially in playgrounds, with artificial stones). These are also equipped with radio. A box for the sewer system costs about 1000 euros each. Remaining open access to the sewer system and shafts after a building demolition increase the rat infestation. In Bonn, specific attention is paid to monitoring these sewer areas during construction work. The sewer system is preferably used by rats to pass through or open up new territories - new exits are created by construction work. During the passage, rats do not accept bait. For effective control, bait must be used where rats actually settle or come to rest. Monitoring baits are also used - especially with the permanent boxes, non-toxic baits are also used (also to prevent habituation to the poison). Poison baits are only used if an infestation is detected. Brodifacoum and Definacoum are used as active ingredients, cholecalciferol (Selontra) is not used.

CONCLUSIONS AND OUTLOOK

Rat control in the city of Vienna has special features that distinguish it from other cities. For example, there is no control in the canal system, which means that a burden on the aquatic ecosystem from washed-out feeding baits is probably minor. On the other hand, the lack of control could also have a negative (i.e. beneficial) effect on the rat population. In addition, there is a protected European hamster population in Vienna, which is potentially endangered by rat control measures with anticoagulants. Therefore, control measures or strategies should be considered that minimise the rat population but do not affect or affect the population of European hamsters.

The evaluation or evaluation of the approved active substances shows that there is rather little room for variation within the framework of approved rodenticides. This applies in particular to second-generation anticoagulants, whose long-term adverse effects on the environment are particularly pronounced. In other words, there is ultimately no alternative to the use of anticoagulant agents. However, it is possible to significantly minimise their application quantity and frequency by eliminating potential food sources and other causes of rat infestation. At least this is shown by the evaluations of best-practice examples from various cities.

Responsible and reduced to a necessary minimum use of anticoagulants ideally takes place in an organizationally optimized framework ("rat management").

The key factors identified for successful rat management are outlined above as a partial result of the study and summarized as follows: The core of such management is a central contact and coordination point equipped with professional and technical resources. It seems essential that the legal framework (i.e. the competence in application) is adapted to the requirements in order to offer effective possibilities for prevention, the investigation and elimination of causes, as well as for the control with biocidal active substances. With these prerequisites, strategies can be developed or combined that contribute to reducing the use of anticoagulants to a necessary minimum or to see them as a last, necessary alternative. This includes, among other things: monitoring of the infestation, measures in waste management and the use of chemical and non-chemical alternatives (traps).

At its core, the present study deals with the high hazardousness of anticoagulant rodenticides (contamination and killing of non-target organisms), alternatives, and ways to avoid or reduce their use. In the case of a commission (or tender) of rat control measures to external service providers, it is

currently not possible for the City of Vienna to exclude certain highly toxic and persistent anticoagulants from their use, as there are no corresponding criteria for this. However, the City of Vienna has a control instrument in the form of the ÖkoKauf procurement programme, which can be used to make the purchase of products and services more sustainable by developing ecological criteria catalogues. Within the framework of this programme, it would be possible to develop a catalogue of criteria for the award of "rat control measures", which is based on the findings of the present study and the working group "Biocide Reduction in Vienna". This catalogue of criteria could be drawn up by an ad-hoc working group. For example, the terms of reference could stipulate that the control with anticoagulant active substances must be preceded by an identification of the cause and, if possible, its elimination. The service provider could also be obliged to justify the choice of the active ingredient used. A restriction of the active ingredients that can be used per application context would also be conceivable.

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APPENDIX I: RODENTICIDES – AUTHORISATIONS & CLASSIFICATIONS

Nr	Eintrag ECHA "information on biocides"	CAS Nummer	BPR Zulassung PT14 (Abfrage vom 06.03.2025)	Stoffinformation ECHA "Substance Infocard"	harmonisierte Einstufung	Einstufung REACH Dossier	BPR Dokument: Stellungnahme des Ausschusses für Biozidprodukte (BPC) bzw. Wirkstoffbericht für jeweils zugelassene Produktart (PT)
Antikoagulantien 1.Generation							
1	Chlorophacinon	3691-35-8	zugelassen - Erneuerung laufend	-	H300, H310, H330, H372 (Blut), H360D, H400 (M1), H410 (M1); **RAC Op**.: Korr., Hautsens., Muta., Karz.: keine Einstufung	-	H300, H310, H330, H372 (Blut), H360D, H400 (M1), H410 (M1)
2	Coumatetralyl	5836-29-3	zugelassen - Erneuerung laufend	-	H300, H311, H330, H372 (Blut), H360D, H410 (M10); **RAC Op.**: Korr., Hautsens., Muta., Karz.: keine Einstufung	-	**RAR & BPC Op**.: H300, H311, H330, H372 (Blut), H360D, H410 (M10)
3	Warfarin	81-81-2	ausgelaufen	-	H300, H310, H330, H372 (Blut), H360D, H411; **RAC Op**.: Korr., Sens.,: keine Einstufung	H300, H310, H330, H360D, H372 (Blut, hematopoetisches System), Aq. Tox (akut): keine Einstufung, H411	**RAR & BPC Op**.: H300, H310, H330, H372 (Blut), H360D, H411
4	Warfarinnatrium	129-06-6	ausgelaufen	H300, H310, H330, H360, H372	-	-	**RAR (2009)**: R26/27/28, R61, R48/23/24/25, R52 (H300, H310, H330, H360D, H372, H412); Korr., Sens.: keine Effekte/Einstufung
Antikoagulantien 2.Generation							
5	Brodifacoum	56073-10-0	zugelassen - Erneuerung laufend	Einige Datenquellen bewerten den Stoff als hautsensibilisierend	H300, H310, H330, H372 (blood), H360D, H400 (M10), H410 (M10)	-	**RAR**: H300, H310, H317, H330, H372, H360D, H400 (M10), H410 (M10); Korr.: keine Einstufung
6	Difethialon	104653-34-1	zugelassen - Erneuerung laufend	-	H300, H310, H330, H372 (Blut), H360D, H400 (M100), H410 (M100), EUH070; **RAC Op**.: Korr., Sens., Muta., Karz.: keine Einstufung	-	**BPC Op**.: H300, H310, H330, H372 (Blut), H360D, H400 (M100), H410 (M100), EUH070
7	Flocoumafen	90035-08-8	zugelassen - Erneuerung laufend	-	H300, H310, H330, H372 (Blut), H360D, H400 (M10), H410 (M10); **RAC Op**.: Korr., Hautsens., Muta., Karz.: keine Einstufung	-	**RAR & BPC Op**.: H300, H310, H330, H372 (Blut), H360D, H400 (M10), H410 (M10)
8	Bromadiolon	28772-56-7	zugelassen - Erneuerung laufend	-	H300, H310, H330, H372 (Blut), H360D, H400 (M1), H410 (M1); **RAC Op**.: Korr., Hautsens., Muta., Karz.: keine Einstufung	-	**BPR Op.:** H300, H310, H317, H330, H372, H360D, H400 (M1), H410 (M1)
9	Difenacoum	56073-07-5	zugelassen - Erneuerung laufend	-	H300, H310, H330, H372 (Blut), H360D, H400 (M10), H410 (M10); **RAR**.: Korr., Hautsens., Muta.,: keine Effekte/Einstufung	-	**RAR & BPC Op**.: H300, H310, H330, H372 (Blut), H360D, H400 (M10), H410 (M10)
10	alpha-Bromadiolon	-	Erstzulassung laufend	-	Vorgeschlagene harmonisierte Einstufung: H300, H310, H330, H372, H360D, H412	-	-

Nr	Eintrag ECHA "information on biocides"	CAS Nummer	BPR Zulassung PT14 (Abfrage vom 06.03.2025)	Stoffinformation ECHA "Substance Infocard"	harmonisierte Einstufung	Einstufung REACH Dossier	BPR Dokument: Stellungnahme des Ausschusses für Biozidprodukte (BPC) bzw. Wirkstoffbericht für jeweils zugelassene Produktart (PT)
Wirkstoffe über die Gasphase							
11	Phospin freisetzendes Aluminiumphosphid	20859-73-8	zugelassen - Erneuerung laufend	-	EUH029, EUH032, H260, H300, H311, H330, H400 (M100)	-	**RAR (according to RAC Op.)**: H260, H300, H311, H330, H400
12	Cyanwasserstoff	74-90-8	zugelassen - Erneuerung laufend	-	**hydrogen cyanide…%:** H300, H310, H330, H400, H410; **hydrogen cyanide:** H224, H330, H400; H410	H300, H310, H330, Korr., Sens.: keine Daten, H372 (Schildrüse), CMR: keine Einstufung; H400 (M?), H410 (M?)	**RAR**: H224, H330, H400, H410
13	Kohlendioxid	124-38-9	ausgelaufen	H280, H281	-	-	**BPC Op. (PT15):** menschliche Gesundheit und Umwelt: keine unannehmbaren Effekte
Sonstige Wirkstoffe							
14	Cholecalciferol (Vitamin D3)	67-97-0	zugelassen - Erneuerung laufend	-	H300, H310, H330, H372; **RAC Op.**: Korr., Hautsens., Muta., Repro., Karz.: keine Einstufung	-	H300, H310, H330, H372 (alle Wege)
15	alpha-Chloralose	15879-93-3	zugelassen - Erneuerung laufend	Bewertung wegen hormoneller Wirksamkeit (laufend)	H301, H332, H336, H400 (M10), H410 (M10)	-	**RAR:** R20/22, R50/53; Korr., Sens., Repro., Karz.: keine Effekte
16	Maiskolben, pulverisiert / powdered corn cob	-	ausgelaufen	-	-	-	**RAR**: keine Einstufungen erforderlich (explizit für: Akute Tox.; Korr; Sens., chron. Tox., Muta., Repro., Karz.; Aq. Tox.)

FIGURE 19: OVERVIEW OF RODENTICIDES: APPROVAL STATUS AND RELEVANT CLASSIFICATIONS.

APPENDIX II: ABC CATEGORIZATION

The results of the ABC categorization are evaluated in 6 hazard categories. Four categories concern human health, such as acute toxicity, irritant or corrosive effect, sensitizing properties or carcinogenic, mutagenic, toxic to reproduction and chronic toxic properties. Two categories relate to the aquatic environment (acute and chronic toxic properties). In addition, the categorization is linked to a color code and is thus distinguished between questionable and less questionable hazards on the basis of the H-phrases [46].

Category A substances are substances of high concern and are labelled in red (see Figure 20). These substances pose a high and/or irreversible hazard in low concentrations. This category includes highly ecotoxic substances as well as those that are mutagenic, carcinogenic, toxic for reproduction, chronically toxic and allergenic. Substances that have a toxic effect are also included in this category [46].

Kategorie A – sehr hohe Besorgnis (Gesundheitsgefährdungen)	
H317	Kann allergische Hautreaktionen verursachen
H334	Kann bei Einatmen Allergie, asthmaähnliche Symptome oder Atembeschwerden verursachen
H372	Schädigt die Organe bei längerer oder wiederholter Exposition
H361d	Kann vermutlich das Kind im Mutterleib schädigen
H362	Kann Säuglinge über die Muttermilch schädigen
H340 H350 H360	Kann genetische Defekte verursachen Kann Krebs erzeugen Kann die Fruchtbarkeit beeinträchtigen oder das Kind im Mutterleib schädigen
Kategorie A – sehr hohe Besorgnis (Gefährdung der aquatischen Umwelt)	
H400 (M ≥ 1000)[4]	Sehr giftig für Wasserlebewesen mit M-Faktor gleich oder größer 1000
H410 (M ≥ 100)[4]	Sehr giftig für Wasserlebewesen mit langfristiger Wirkung mit M-Faktor gleich oder größer 100

FIGURE 20: OVERVIEW OF THE CLASSIFICATION CRITERIA FOR CATEGORY A - VERY HIGH CONCERN.

Substances classified as 'of high concern' are marked in yellow (see Figure 21). This includes substances that have significant adverse effects on human health and the aquatic environment. The H-

phrases H300, H301, H310, H311, H330 and H331 are included in category B because their effect is concentration-dependent and decreases significantly with the usual dilution. Data gaps and uncertainties fall under category B. When assigning to category B, product alternatives should be considered on a case-by-case basis [46].

Kategorie B – erhebliche Besorgnis (Gesundheitsgefährdungen)	
H300	Lebensgefahr bei Verschlucken
H310	Lebensgefahr bei Hautkontakt
H330	Lebensgefahr bei Einatmen
H301	Giftig bei Verschlucken
H311	Giftig bei Hautkontakt
H331	Giftig bei Einatmen
H341	Kann vermutlich genetische Defekte verursachen
H351	Kann vermutlich Krebs erzeugen
H361f	Kann vermutlich die Fruchtbarkeit beeinträchtigen
H373	Kann die Organe schädigen bei längerer oder wiederholter Exposition
EUH029	Entwickelt bei Berührung mit Wasser giftige Gase
EUH031	Entwickelt bei Berührung mit Säure giftige Gase
EUH070	Giftig bei Berührung mit den Augen
H370	Schädigt die Organe
Kategorie B – erhebliche Besorgnis (Gefährdung der aquatischen Umwelt)	
H400 (M ≥ 10)[5]	Sehr giftig für Wasserorganismen mit M-Faktor gleich oder größer 10
H410 (M ≥ 1)[5]	Sehr giftig für Wasserorganismen mit langfristiger Wirkung mit M-Faktor

FIGURE 21: OVERVIEW OF CATEGORY B CLASSIFICATION CRITERIA - SIGNIFICANT CONCERN

Category C covers substances that pose a limited, controllable or reversible hazard (see Figure 22). These include substances with corrosive properties (H314 and H318). It is taken into account that the corrosive properties decrease with increasing dilution and can be controlled by suitable occupational health and safety measures. Although hazards classified as category C are not negligible, such substances should be preferred [46].

Kategorie C – geringe Besorgnis (Gesundheitsgefährdung)	
H302 **H312** **H332**	Gesundheitsschädlich bei Verschlucken Gesundheitsschädlich bei Hautkontakt Gesundheitsschädlich bei Einatmen
H314	Verursacht schwere Verätzungen der Haut und schwere Augenschäden
H318	Verursacht schwere Augenschäden
H315	Verursacht Hautreizungen
H319	Verursacht schwere Augenreizungen
H335	Kann die Atemwege reizen
H371	Kann die Organe schädigen
H304	Kann bei Verschlucken und Eindringen in die Atemwege tödlich sein
EUH066	Wiederholter Kontakt kann zu spröder und rissiger Haut führen
EUH071	Wirkt ätzend auf die Atemwege
Kategorie C – geringe Besorgnis (Gefährdung der aquatischen Umwelt)	
H400 (M < 10)[6]	Sehr giftig für Wasserorganismen mit M-Faktor kleiner 10
H411	Giftig für Wasserorganismen, mit langfristiger Wirkung
H412	Schädlich für Wasserorganismen, mit langfristiger Wirkung
H413	Kann für Wasserorganismen schädlich sein, mit langfristiger Wirkung

FIGURE 22: OVERVIEW OF CLASSIFICATION CRITERIA FOR CATEGORY C - LOW CONCERN

SHORT DESCRIPTION / ABSTRACT

Abstract

Rat control in the city of Vienna has special features that distinguish it from other cities. In Vienna, there is a protected European hamster population that is potentially endangered by rat control measures with anticoagulants. Therefore, control measures or strategies should be considered that minimise the rat population but do not affect or affect the population of European hamsters. At its core, the present study deals with the high hazardousness of anticoagulant rodenticides (contamination and killing of non-target organisms), alternatives, and ways to avoid or reduce their use. The evaluation or evaluation of the approved active substances shows that there is rather little room for variation within the framework of approved rodenticides. This applies in particular to second-generation anticoagulants, whose long-term adverse effects on the environment are particularly pronounced. However, it is possible to significantly minimise their application quantity and frequency by eliminating potential food sources and other causes of rat infestation. At least this is shown by the evaluations of best-practice examples from various cities. Responsible and reduced to a necessary minimum use of anticoagulants ideally takes place in an organizationally optimized framework ("rat management"). The key point identified for successful rat management is a central point of contact and coordination equipped with professional and technical resources. The legal framework (i.e. the competence in application) should be adapted to the requirements and effective possibilities for prevention, root cause research and elimination as well as for the control of biocidal active substances should be offered.

Abstract

Rat control in the city of Vienna has special features that distinguish it from other cities. In Vienna,there is a protected field hamster population that is potentially endangered by rat control measures WITH anticoagulants. Therefore, control measures or strategies should be considered that minimise the rat population but do not affect or affect the population of field hamsters. At its core, the present study deals with the high hazardousness of anticoagulant rodenticides (contamination and killing of non-target organisms), alternatives, and ways to avoid or reduce their use. The evaluation of the approved active subtances shows that there is rather little room for variation within the framework of approved rodenticides. This applies in particular to second-generation anticoagulants, whose LONG-TERM adverse effects on the environment are particularly pronounced. However, it is possible to significantly minimise their application quantity and frequency by eliminating potential food sources and other causes of rat infestation. At least this is shown by the evaluations of best-practice examples from various cities. Responsible and reduced to a necessary minimum use of anticoagulants ideally takes place in an organizationally optimized framework ("rat management"). The key point identified for successful rat management is a central point of contact and coordination equipped with professional and technical resources. The legal framework (i.e. the competence in application) should be adapted to the requirements and effective possibilities for prevention, root cause research and elimination as well as for the control of biocidal active substances should be offered.