Improvement of knowledge about the method of application of biocidal products PT8, 14 and 18

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1- Context and aim of the study

Biocides are "Active substances and preparations containing one or more active substances, put up in the form in which they are supplied to the user, intended to destroy, deter, render harmless, prevent the action of, or otherwise exert a controlling effect on any harmful organism by chemical or biological mean" (Directive 98/8/CE).
The biocides are characterized by a very wide scope of application and cover a vast whole of human activities in the non agricultural field. More than 600 biocides are approved in Belgium. They are classified of 23 different types (human hygiene, disinfecting for water of drink, rodenticides, avicides…). The forms in which the biocides are presented are also very diverse (liquid, powder, aerosol sprayer, bait…). This great diversity implies a large number of methods of application.

To be put on the market, a biocide must obtain an authorization coming from the Federal Public Service (health, food chain safety and environment). The approval form must contain a technical part (article 5 of the AR of May 22, 2003 appendix II B) in which the method of application of biocide, as well as the description of the material used, must be specified. Nevertheless, these data are often very brief and do not allow the administration to assess the feasibility of the treatment.

The overall purpose of this study is to give a description of the techniques of biocide's application and to provide tools to the agents in charge of the evaluation of new products. Taking into account the large number of biocides, the state of the art and the inventory of the techniques of application will be limited to the 3 following types of biocides: wood preservatives (product type 8), rodenticides (product type 14) and insecticides, acaricides and products used to fight against the arthropods (product type 18). They form together about half approved product in Belgium and are certainly the biocides which raise the most questions.

The specific objectives are, for product types 8, 14 and 18:
- listing of the relevant factors linked to the method of application;
- inventory and description of the methods of application;
- inventory and description of the equipments of application used for each method;
- inventory of contact people for each method/equipment of application (retailer, producer, user…);
- outline of the research orientations and prospects for methods of application;

A database was built to gather all information about the methods and equipments of application.

2- Relevant factors for the utilization of biocidal products

2.1- Active substance

The parameters important to know in order to evaluate the impact of the product on the risk of exposure are (Human exposure assessment and environmental exposure assessment, ECB 2006; Réduction des contaminations des eaux souterraines et des captages en particulier par les pesticides, CRA-W 2006):

- *Vapour pressure (risk of inhalation)* indicate whether a substance may be available for inhalation as a vapour. Highly volatile substances are those with a vapour pressure greater than 25 Kpa and substances with low volatility have a vapour pressure <0,5 KPa.

- *Particle size (risk of inhalation, dermal exposure)*: % of particle <100 µm, limit 1% on a weight basis of particle <100 µm.

- *Concentration of the active substance (level of exposure)* to calculate the total quantity of active substance applied during one application.

- *Log P value (risk of dermal or blood absorption).* Relative solubility of the substance in water and in octanol, if >0 the substance is more soluble in octanol than in water. A value between 0 and 4 is favourable for dermal and blood absorption (through the respiratory tract) **if** the solubility is high enough (>>1 mg/litre) and **if** the molecular weight is not too large <500. For high solubility, > 10 000 mg/l, if the Log P = 0 the substance is too hydrophilic to cross the skin.

- *Water solubility (risk of dermal and blood absorption, mobility of the substance trough the environment).* WS <1 mg/litre low solubility, between 1-100 mg/l absorption is anticipated to be low to moderate and between 100 and 10 000 mg/l moderate to high.

- *Molecular weight (risk of dermal absorption).* If MW >500 too large to pass the skin.

- *DT50: Half life value.* DT50 is the time needed (in days) to observe the degradation of 50% of the applied substance. The more the DT50 increase the more the substance is persistent. DT50>30-100 days: relatively persistent.

- *Koc: coefficient of adsorption.*

2.2- Annex of inclusion of the active substance

If included in the Annex IA, the active substance has a low risk potential. This means no carcinogen, mutagen, toxicity on reproduction and sensitisation effects, no bioaccumulation and an easier degradation (Directive 98/8/CE).

2.3- Formulation

The formulation is the form under which the product is available, for example: concentrate, powder, emulsifiable concentrate, bait… This parameter has an impact on the method of application and on the way of exposure for humans, animals and environment.

The formulation used for biocidal products are less precise than for the one used for pesticides (see fytoweb.fgov.be). For example, in the authorization acts for concentrate solution, it's often not mentioned which type of concentrate it is.
Appendixes given by the European Chemicals Bureau concerning the formulation used for biocides are also not very precise.
For this study the international code and name for the formulation were used (Manual on development and use of FAO and WHO specifications for pesticide, March 2006, FAO).

2.4- Preparation before use

Is the product *ready to use* or is it necessary to prepare it before application?
For example: dilution of a concentrate with water, preparation of grain bait by mixing a solution with cereals. This increase risks for the user.
Are they *sufficient information about the way of preparing* the product before use?
If not enough information: risk of bad preparation: overdosing, lack of efficacy…
Are they *information about the cleaning of material used for the preparation*? If not enough information: risk of exposure of the environment by the product.

2.5- Method of application

The method of application is the way the product will be applied by users. For example: spraying, spreading, impregnation… This parameter has a direct impact on the exposure of the user.
Some methods of application need the utilization of specific equipment (equipment of application). Different *types of equipment* can be used for the application of one single formulation e.g. impregnation of wood with a double vacuum system or vacuum/pressure system, two different kinds of powder devices…
Quantity of the applied product/application
This leads to calculate the quantity of active substance (with the concentration) applied in one single application and then the risk of exposure for the user.
Frequency and duration of treatment
Has the treatment to be repeated? How many time/year?
What is the duration of the treatment?
These parameters are important to assess the risk of exposure.

2.6- User

Personal protective equipment (PPE)
Do the users wear personal protective equipment?
If no PPE, the risk of dermal exposure or inhalation is higher (depending on the specific properties of the substance and the method of application).
Qualification of the user: professional with specific training, professional or grand public.
For grand public and professionals who are not working on the specific area of biocides (for example: farmers for PT14), very precise explanations should be given in order to prevent bad utilization of the product or accident.

2.7- Conditions and location of application

Conditions during the application

- Temperature of the product: dermal exposure is neglected when the temperature of the product is high (>60°C), risk of burn if handling hot product (Human exposure assessment, ECB).
- External temperature: influence the vaporization of products.

- Windy conditions: especially for powder application, spreading and gazing (outdoor application only).

Location of the application

- Outdoor
    - In a fixed close system (ex bait station with bait attached to the station): no risk of direct contamination of the environment (soil, water), no risk for animals and humans.
    - In an open area :
        - Direct contact with the soil.
        - Can be close to water.
        - Can be transported by animals.
        - Can be eating by animals or humans (kids).
        - Not protected from elements.
- Indoor
    - In a fixed closed system (ex bait station, vacuum system…): no risk of direct contamination of the environment (soil, water), no risk for animals and humans.
    - In an open area:
        - In food storage buildings: risk of food contamination, risk for animals.
        - In living area or working place with or without segregation with eating facilities: risk of contamination during eating, risk for humans and domestic animals.
        - Application in the presence of humans.
        - In farm building for living animals (ex: piggeries…) risk of contamination for animals.

Hazard class of wood (for wood preservatives): 5 classes are defined regarding the future utilization of wood. From class 1: dry wood with no contact with water (indoor use) to class 5: wood in permanent contact with seawater. This allows knowing the possible contact of the product with the environment after treatment.

3- Biocidal products being the subject of the study

3.1- Wood preservatives: product type 8

3.1.1 Introduction

Sources: Le traitement des bois dans la construction, deuxième édition (CTBA, 2003), Guide de la préservation du bois (Michel Rayzal, CTBA, 1998), Analyse des flux de bois traité importé en Belgique destiné aux particuliers et des pratiques d'achat des grands groupes de distribution (Xhonneux, 2008).

Wood is used in a variety of application depending on the type of wood and the use of it. It can be affected by insects or fungi.
The natural durability of the wood depends on the wood species. The wood species are divided into 5 classes (regarding the perfect wood): from 1 (very durable) to 5 (non durable).
At the same time, a classification (5 classes) depending on the condition where the wood will be use exists.

Table 1: Class of utilization

Classes	Conditions of use	Examples	Leaching risk	Insect risk	Mould, fungus risk
1	Indoor in dry conditions	Furniture, wooden floor	/	High	/
2	Indoor or covered occasionally wet	Timber wood	Low	High	Present
3	3.1 outdoor, above ground, protected (occasionally wet) 3.2 outdoor, above ground, unprotected (frequently wet)	Wood exposed to elements or placed in bad conditions	High	Present	High
4	4.1 outdoor, in ground contact and/or fresh water 4.2 outdoor in ground(severe) and/or fresh water	Stake	Very high	Present	Very high
5	Permanent contact with salt water	Floating dock	Very high	Present	Very high

The wood preservative is set aside for giving an additional durability to a wood which is not enough durable for its utilization.
Wood is treated with preservatives at either or both of two distinct stages:

- preventively to prevent the occurrence of biological degradation. Preventive treatments are usually applied at industrial scale operations to wood before the wood is put into service. Although, professionals and amateurs also treat wood structures in situ;
- curatively to remedy infestations once they have occurred. Curative treatments are applied in situ by professionals or amateurs.

3.1.2 Description of products on the market (1/01/08)

Sources: Le traitement des bois dans la construction, deuxième édition (CTBA, 2003), Guide de la préservation du bois (Michel Rayzal, CTBA, 1998), Analyse des flux de bois traité importé en Belgique destiné aux particuliers et des pratiques d'achat des grands groupes de distribution (Xhonneux, 2008), Rapport groupe thématique inclus produits de protection du bois (p 485-536) (PRPB, 2006).

At the 1/01/08, 54 wood preservatives are authorized on the market. The wood preservatives are divided into 5 types.

- Salt based product (Produit à base de sels minéraux).

Those products are formulated with copper, chromium, arsenic and boron. The conditions of utilization of the wood will determine the future leaching of the element. Products containing arsenic are not authorized anymore in Belgium.

- Metallic organic salt (Sels métalliques organiques).

Those products are organic combinations of copper. These products are not soluble in water so they are less sensitive to leaching.

- Light organic solvent (LOSP) (Solutions organiques).

Those products contain a combination of 2 or 3 active substances in an organic solvent (often produced from oil). The problem lies in the emission of solvent during production and utilization. Those products soak well through the wood and are stable.

- Aqueous emulsion (émulsions aqueuses).

They are formulated from organics active substances with active surfactants. They are more respectful to the environment (no metallic salt) and not soluble in water so they are less sensitive to leaching.

- Distillates from coal (produits obtenus par distillation de la houille).

These products are made of a set of molecules stems of the distillation of coal. They are reserved to protect the outside wood because of emission of aromatic compound during the all life of the treated wood.

a) Active substance

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

The figure 1 shows the number of products which contains 1 or more active substances.

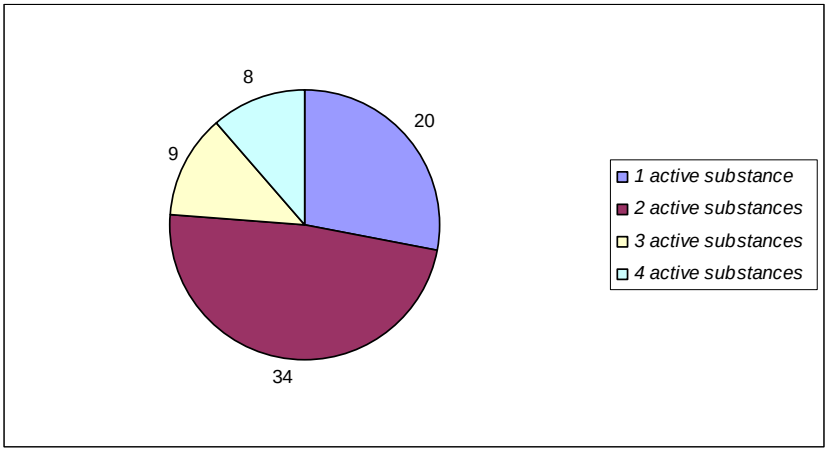


Figure 1: Number of products with 1, 2, 3 or 4 active substances

The figures 2 and 3 present the different associations of active substances for product containing 1 and 2 active substances.

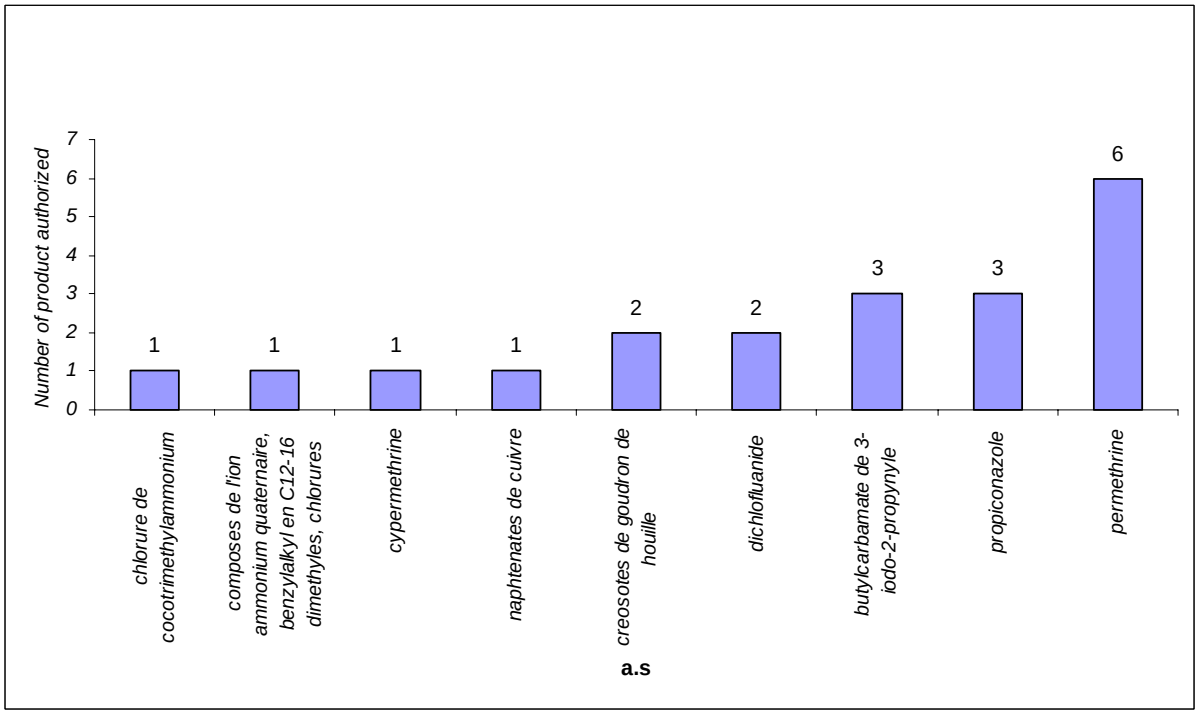


Figure 2: Active substances in product with 1 active substance (a.s)

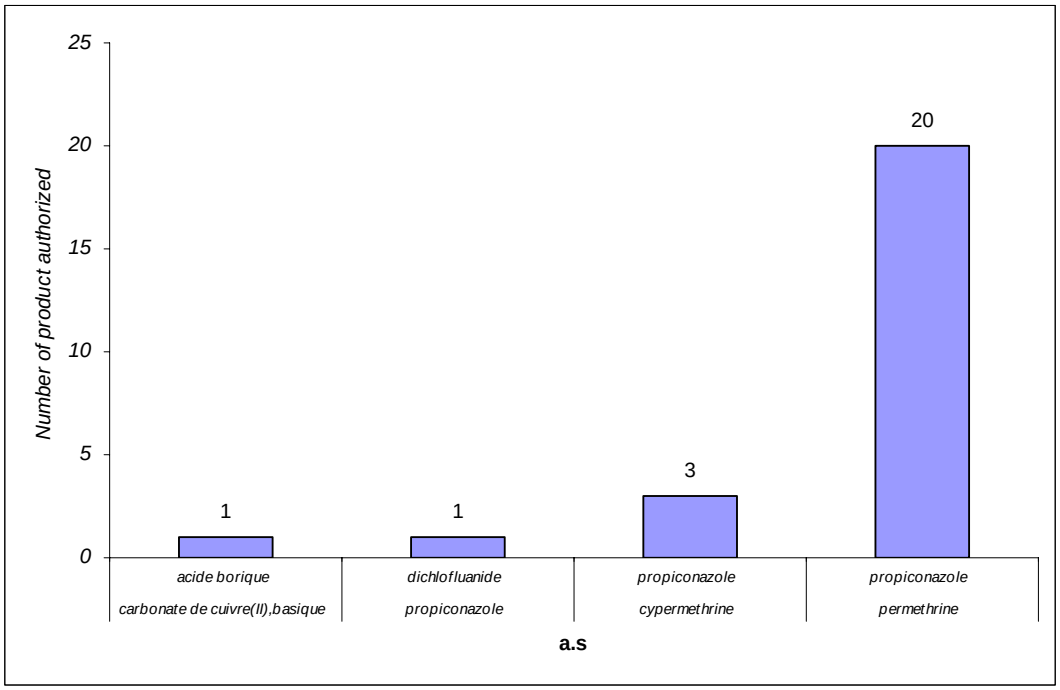


Figure 3: Active substances in product with 2 active substances (a.s)

Active substances used in the wood protective are listed in the table 2.

Table 2: Active substances (PT8)

Active substances
Butylcarbamate de 3-iodo-2-propynyle
Chlorure de cocotrimethylammonium
Composés de l'ion ammonium quaternaire, benzylalkyl en C12-16 dimethyles, chlorures
Creosotes de goudron de houille
Cypermethrine
Dichlofluanide
Naphtenates de cuivre
Permethrine
Propiconazole
Acide borique
Carbonate de cuivre (II),basique
Polymer Betain
Tebuconazol

See also the synthesis « Produits de traitement du bois – composition, dangers, mesures de prévention (aide mémoire technique), INRS 2006 ». This document presents the risks of the different substance active type and can be downloaded at www.irns.fr

b) Function

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

Table 3: Function (PT18)

Function	%
Fungicide	15
Insecticide	13
Fungicide/insecticide	72

c) Hazard classification

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

78% of the available products are not classified and 22% belong to the class A.

d) Class of utilization

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

Only a part of authorization acts mentions clearly the class of utilization for the treated wood (1 to 5). But it is often specified if the treated wood can be use outdoor, indoor or both.

Table 4: Use of wood (PT8)

Use of wood	%
Indoor	5,5
Outdoor	15
Indoor/outdoor	79,5

e) Treatment

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

Table 5: Treatment type (PT8)

Treatment	%
Curative	4
Preventive	20
Curative/preventive	76

3.1.3 Formulation

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

Table 6: Formulation for PT8

Formulation	Code	%
Solution ready for use	AL	74
Emulsifiable concentrate	EC	18
Soluble concentrate	SL	4
Aerosol dispenser	AE	2
Technical concentrate	TK	2

All formulations are liquid formulations, products ready to use represent 76% of the available wood preservatives.

3.1.4 Method of application

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

The methods of application depend on the treatment type (preventive, curative), the type of wood (impregnability between class 1: impregnable and class 4: non impregnable), the class of utilization of wood and the user.

The methods of application mentioned in the authorization acts for the application of wood preservatives are:

- brush treatment;
- aerosol spraying;
- spraying;
- injection;
- dipping;
- impregnation in autoclave: double vacuum system;
- impregnation in autoclave: pressure/vacuum system.

No product is registered as a biocide PT8 for fumigation application. The fumigants are classified as PT 18 or for special treatment (like in container before shipment).
The methods of application can be classified regarding different parameters.

Table 7: Classification of the method of application

Method of application	Type of treatment	User	Class of utilization
Brush treatment	Preventive/curative	Amateur/professional	1,2
Aerosol spraying	Curative	Amateur/professional	1,2
Spraying	Preventive/curative	Professional/amateur	1,2
Injection	Curative	Professional/amateur	1,2,3
Dipping	Preventive	Professional/amateur	1,2,3
Impregnation double vacuum system	Preventive	Professional	1,2,3,4,5
Impregnation pressure/vacuum system	Preventive	Professional	1,2,3,4,5

The treatment by autoclave allows deep impregnation of the wood.
Regarding the authorization acts, products can be applied by one or several methods of application.

Table 8: Method of application (% of number of products)

Method of application	%
Brush treatment	22
Brush treatment/dipping/spraying	13
Impregnation autoclave	11
Brush treatment/spraying	9
Brush treatment/spraying/injection	9
Brush treatment/spraying/injection/dipping	7
Brush treatment/dipping/spraying/impregnation in autoclave	7
Dipping/spraying/impregnation in autoclave	6
Brush treatment/dipping	4
Brush treatment/injection	4
Brush treatment/injection/dipping	2
Injection	2
Spraying	2
Brush treatment/spraying/impregnation in autoclave	2

3.1.5 Equipment of application

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

The equipments of application which can be used for the application of wood preservatives are listed in the table 9.

Table 9: Equipment of application (PT8)

Equipment of application	Method of application	User
Paint brush or brush	Brush treatment	Amateur/professional
Syringe Injection devices	Injection Injection	Amateur Professional
Sprayers Spraying tunnel	Spraying Spraying	Professional/amateur Professional
Autoclave Double vacuum system Pressure/vacuum system	 Impregnation double vacuum process Impregnation pressure/vacuum process	 Professional Professional
Pot for dipping Dipping vat	Dipping Dipping	Amateur Professional

Professional stations of treatment can get technical approval on a voluntary basis (ATG): autoclave, tunnel for spraying and tank for dipping process. The list of units having a technical approval is available on the website of the Belgian Institute for wood technology (www.ctib.techn.be).

3.1.6 Risk assessment

Sources: Development of BiBel-indicator for PT8 biocides, draft report (2008), Emission scenario document for wood preservatives part 1 to 4 (OECD, 2006).

The risks assessments are divided into the human risk assessment and the environmental risk assessment. In order to assess the risk, it is important not to only consider the property of the active substance but also to take into account the emissions due to the method of application and the future use of wood.

a) *Human risk assessment*

Direct exposures considered for risk assessment are:

- dermal exposure: mixing/loading the product before application, handling of wet treated wood, projection during application (spraying, injection, dipping, brush treatment);
- inhalation exposure: spraying, fumigation, solvent emission (LOSP products);

Ingestion exposure is not considered.

Secondary exposure which occurs following biocide application

- dermal exposure: contact with surfaces still wet;
- inhalation exposure: re-entering treated sites after treatment (spraying, fumigation) or volatilized residues in treated buildings (chronic secondary exposure);

Secondary exposure which occurs during the life of the treated wood:

- sanding of a treated wood;
- infant picks up and chews treated wood off-cut;
- child playing on a treated wood structure.

The emission scenario (OECD, 2006) presents the way to calculate the emission in the environment factors while the Draft for the development of BiBel indicators PT8 presents the calculated risk of exposure.

b) Environmental risk assessment

The environment compartments that have to be considered during the treatment, the storage and the use of the treated wood are:

- outdoor air during application process (spraying, fumigation);
- waste water compartment which may enter in the surface water via the sewage treatment plant during application process;
- soil due to leaching from the treated wood or during application (outside application);
- animals via contact (bats);
- fresh water if application near a fresh water source;
- sea water due to leaching from wood (class of utilization: 5).

For treatment realized in industrial unit (well controlled indoor conditions) as for direct indoor in situ treatment (except for fumigation), the direct emissions in the outdoor air compartment during application are negligible.

The draft report on BiBel indicators development presents the emission factors (F: weight of the product released divided by the quantity of applied product) for different method of application. The results given in this draft have to be confirmed in a final report.

The emission in the air depends on the method of application (spraying, fumigation) and also on the vapour pressure of the product. The emissions on the soil compartment are linked to the water solubility of the product, the fixation during the process and the use of the wood.

3.2- Rodenticides : product type 14

3.2.1 Introduction

Sources: PRPB-Groupe de travail rodenticides, PRPB 2006. Emission scenario document for biocides used as rodenticides, EUBEES, 2003.

Product-type 14 is defined as Rodenticides. They are used to fight against mice, rats and other rodents. In general all rodenticides have to be considered as biocidal products with the exclusion of products used in plant growing areas to protect plants (like field mouse, vole and mole). However, in Belgium, some biocides are approved as pesticides for agricultural use till the expiry of their renewal.
In Belgium, the PT14 are mainly used against: brown rat, black rat, mouse and muskrat. The fight is carried out using baits of various formulations which can be applied inside or outside in a large variety of places (sewer system, houses, buildings, waste dumps, dikes…) by professional or grand public.
Almost all PT14 have an anticoagulant action, the mechanism of coagulation of blood is disturbed what results in haemorrhages and the death of the animal a few days after the ingestion of the poison. The advantages are that differed death does not wake up the mistrust of the rodents and that an antidote is well known and easily available (K1 vitamin), so in the event of ingestion it is possible to begin in time the adequate treatments. On the other hand, the risk of accidental intoxication by a non target animal or human is high.

According to their stability in the rodent's organism and to their toxicity, the anticoagulant substances are classified as first, second or third generation. The molecules of first generation are rather unstable and require several successive intakes of poison to obtain a lethal effect (warfarine, chlorophacinone, coumatetralyl). The second are more stable (difenacoum, bromadiolone). The third are even more stable but also more toxic; one intake of bait is enough to kill a rodent (brodifacoum, diféthialone, flocoumafène). The second and third generations of anticoagulant are 10 times more toxic than the first generation ones (in term of DL50).

3.2.2 Description of products on the market (1/01/08)

58 products are authorized in Belgium (1/01/2008) as biocides-PT 14 and 14 others products with a rodenticide action are listed in the pesticide list (see www.fytoweb.be).

a) Active substance

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

Except aluminium phosphide (high toxicity) and CO_2 (suffocating) all others active substances have an anticoagulant action.
The figure 4 presents the actives substances for PT14.

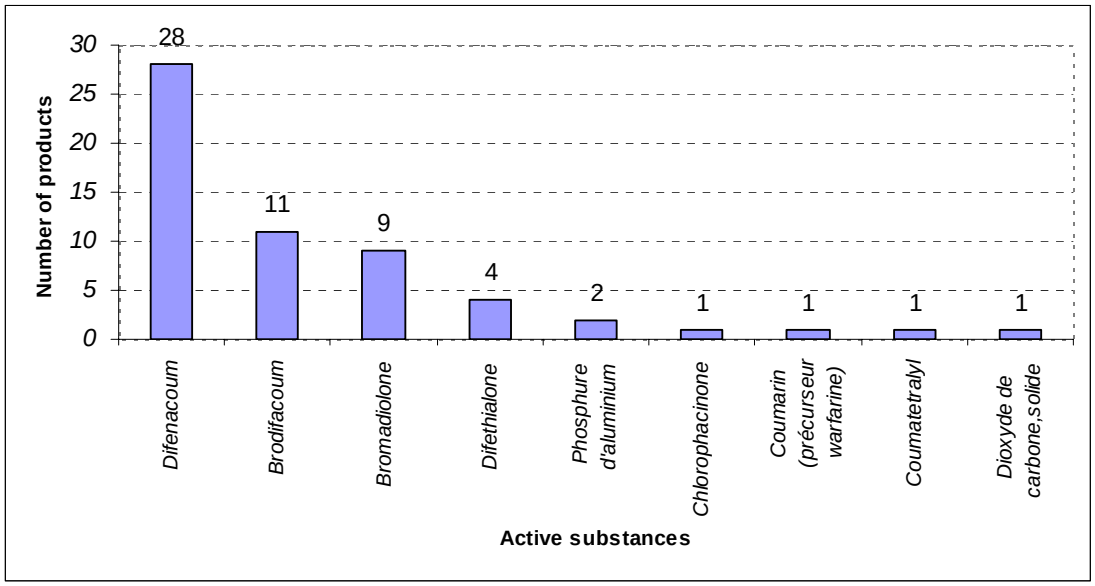


Figure 4: Active substances for PT14

Among the PT14 with an anticoagulant action, the first generation represents only 5% (3 products out of 55) while more toxic anticoagulants (second and third generation) represent 95% of the products (see figure 5).

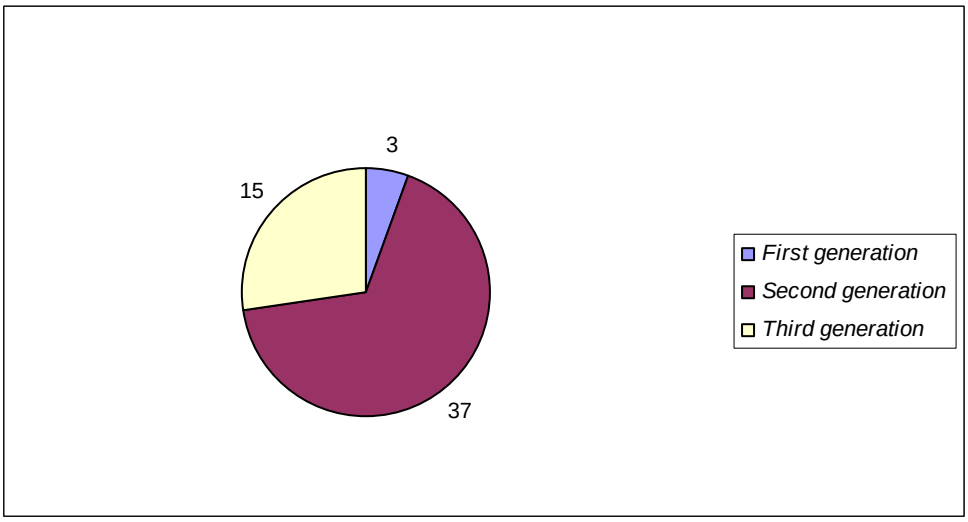


Figure 5: Generation of anticoagulants (number of products)

b) Hazard classification

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

3 products belong to class A (5%). Additionally for 16 products (28%), the authorization act mentions a professional utilization even if they are not classified. The meaning of professional use may vary. The term indicates that professionals are assumed to have a minimum of knowledge of the substance they are handling by training or education whereas non professionals (grand public) are assumed to have a little or no knowledge.

3.2.3 Formulation

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

The formulations are presented in the figure 6.

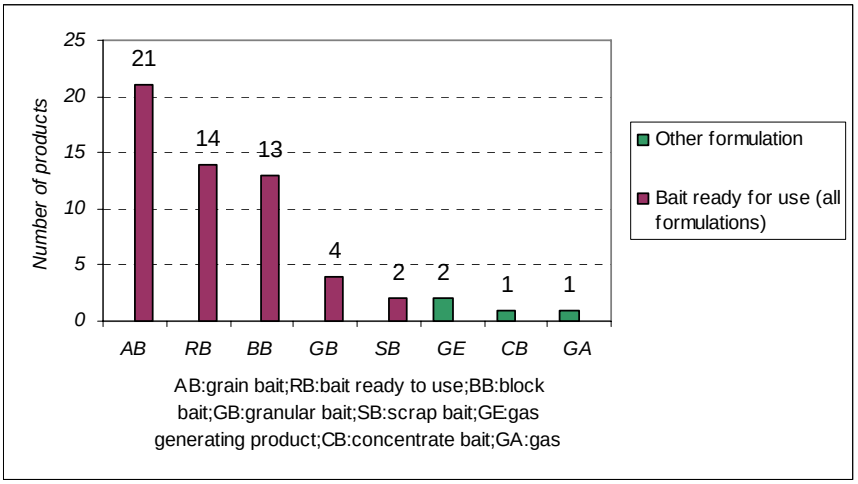


Figure 6: Formulations for PT14

Baits ready for use (AB, RB, BB, GB and SB) represent 93% of the authorized products. The RB formulation included all bait ready for use for which specific international code doesn't exist. The forms of bait included in the RB formulation are presented in the following figure.

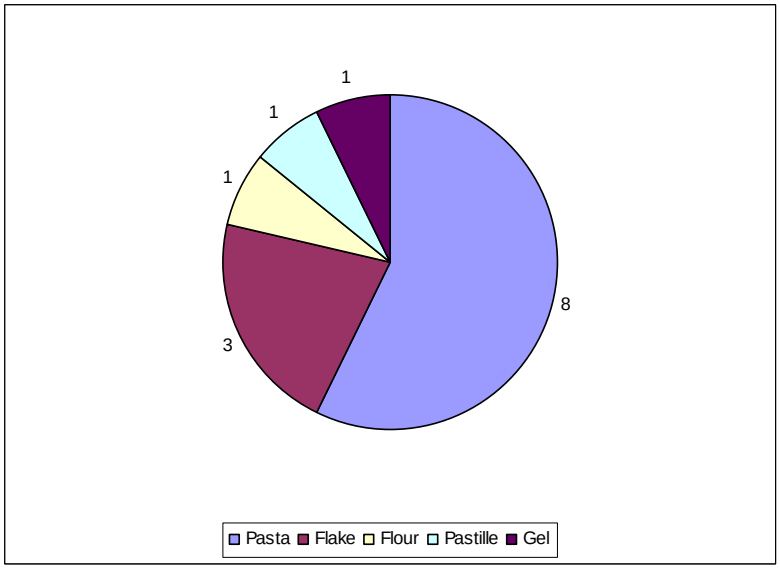


Figure 7: Type of bait ready for use, RB (number of products)

3.2.4 Method of application

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

For biocides PT 14, the methods of application are presented in table 10.

Table 10: Method of application for PT14

Method of application	Number of products	%
Direct laying of bait and direct laying of bait in wet conditions	54	92
Gasification	1	2
Fumigation with gas generating product	2	4
Gel injection	1	2

The powder application is not mentioned because the only track powder authorized on the market is a pesticide.

3.2.5 Equipment of application

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

The equipments of application which can be used for the application of rodenticides are:

- bait box;
- gel gun;
- mousetrap;
- duster.

3.2.6 Field of use

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

The products available on the market can be used for indoor (50% of the products), outdoor applications (3%) or both (47%).
For indoor application, limitations exist about the area of application (see figure 8).

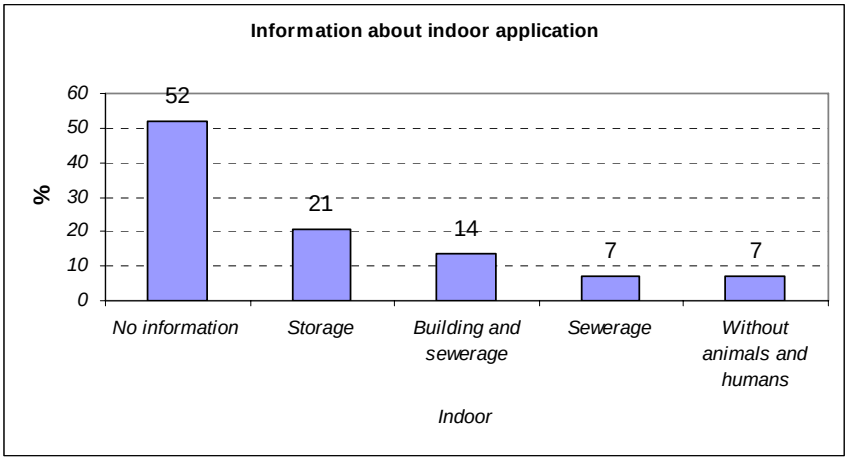


Figure 8: Indoor application (% of products)

3.2.7 Risk assessment

Sources: Emission scenario document for biocides used as rodenticides, EUBBES 2003. PRPB-Groupe de travail rodenticides, PRPB 2006. Evaluation de l'impact environnemental de la lutte chimique contre le rat musqué basée sur l'utilisation d'appâts carotte, CRA-W 2008.

The risks assessments are divided into the human risk assessment and the environmental risk assessment. In order to assess the risk, it is important to consider either the property of the active substance and the method of application.

a) Human risk assessment

Looking at the important part of bait ready to use (93%), the risk of human exposure is limited to ingestion by accident. The risk of inhalation is linked to the use of pellet/tablet generating gas and powder. The risk is reduced because of the restriction of utilization (class A) and the strict conditions of utilization.

The dermal exposure can occur during the deposit of bait or during preparation of bait with concentrate. This risk of exposure is reduced by the wearing of gloves.

Non-target vertebrates may be exposed to rodenticides primarily through consumption of bait (small pellets and whole grain baits are highly attractive to birds) and secondarily from consumption of poisoned rodents. According to the results of a study made by the CRA-W (2008), the secondary poisoning of animals is not observed with anticoagulant of first generation. The use of bait box allows reducing this risk as the laying of bait in places unreachable for non targets animals. In sewage system the risk of poisoning by non target animals is considered as negligible because it is assumed that the rodents will stay in the sewage system and that no other animals live there.

b) Environmental risk assessment

Direct environmental exposure may take place when rodenticides are applied outdoors on public or private areas around buildings, on water banks, in and around sewer systems and waste dumps. Indoor application may result in environmental exposure via release to the sewage system (cleaning). However, this emission is assumed to be insignificant by the experts in the emission scenario document.

A diffuse releasing from target animals via urine and faeces may be anticipated around the controlled area.

4 scenarios are considered in the emission scenario document from EUBEES (2003):

- For sewer system.

A maximum release to the sewerage plant comes directly from residues of bait and indirectly from rodents (urine, faeces and carcasses).

- In and around buildings.

The main exposure of the environment is expected to be soil contaminated during outdoor application, refilling and disposal operations. The rodents may also disperse the bait during its use period. Outdoor application directly into burrows is assumed to create the larger release to the environment.

- For open area (control of rodents in open area such as park, golf…).

The main release to the environment is expected when product is applied into rat holes. The application of track powder into rodent burrows is considered the situation which the highest environmental release to the soil. In fact, the amount of materiel ingested by the target animal is small compared to the applied amount and the concentration of active substance in tracking powders is higher than in other baits containing the same active substance (for example: Racumin powder 0,75% of coumatetralyl and Racumin pasta 0,0375% of coumatetralyl).

- For waste dump. The environmental compartment that can be exposed is soil.

3.3- Insecticides, acaricides and products used to fight against the arthropods: Product type 18

3.3.1 Introduction

Sources: Emission scenario document for insecticides for stables and manure storage systems, OECD 2006. 4th Draft emission scenario document for PT18 for household and professional uses, OECD 2008. Health and environmental effects of pesticides and PT18 biocides (HEEPEBI), PRPB 2006. Borderline between Directive 98/8/EC concerning the placing on the market of biocidal products, Directive 2001/83/EC concerning medicinal products for human use and Directive 2001/82/EC concerning veterinary medicinal products, guidance document EU 2008.

Product-type 18 is defined as "Insecticides, acaricides and products to control other arthropods" and covers products used for the control of arthropods.
Within the biocides type 18, insecticides are biocides for controlling insects like cockroaches, bugs, flies, mosquitoes, ants…and other insects in non-agricultural application. These insects are parasites or vector systems and cause several diseases to human/domestic animals. Acaricides are biocides used against mites, spider, dust mites…
Biocidal products of type 18 are used in many different applications: in and around domestic, public and industrial buildings, in sewer systems, in animals housing to control parasites, on domestic animals for external parasites (without therapeutic indications) and to control insects in food storage.
In specific cases, there may be borderline cases with food and feeding area disinfectants (PT4), veterinary medicinal products (PT3), wood preservatives (PT8) and other veterinary medicinal products. In the EU, the borderlines with other EU directives and other product types are important issues. The borderline between PT18 and human and veterinary medicinal product were already discussed (see Borderline between Directive 98/8/EC concerning the placing on the market of biocidal products, Directive 2001/83/EC concerning medicinal products for human use and Directive 2001/82/EC concerning veterinary medicinal products, guidance document EU 2008.
http://ec.europa.eu/environment/biocides/pdf/bordermedvet.pdf).
Following the EU recommendations:

- Products used in areas in which animals are housed, kept or transported in

order to kill external parasites by treating the structures but not the animal, including situations where the products are intended to be active while animals are in the structures, are classified as biocidal products.

- The classification of products containing active substances with lethal

effects on external parasites to be used on human beings or animals will depend on the intended use and/or demonstrated claim. Generally, such products used on human beings/animals are at present considered and authorised as human/veterinary medicinal products with precise medicinal indications (including prevention or treatment of disease). On the basis of this criterion, the following examples would normally be considered medicinal products, in particular when there is a medicinal claim, but in the absence of such a claim and in specific cases could be considered as biocidal products:

- products (insecticides) used for sheep dipping for the control of

external parasites;

- products for the control of external parasites of fish, used by

adding the products to the water where fish swim;

- products/articles which contain an insecticide or another active

substance with a lethal activity or with an effect on growth or reproduction of the harmful arthropods, for example collars, neckties, ears marks etc.

The variability of the targets and places of application involves a great variability with regards to formulations and methods of application.
The market for product-type 18 can be divided into 3 main sectors depending on their utilization:

- for “domestic use” : in an around buildings against flying and crawling insects and other arthropods (mites…);
- for professional use : in an around buildings (industrial, food storage,…) against flying and crawling insects and other arthropods (mites…);
- against parasites (for domestic animals) : on animals and in animals houses.

3.3.2 Description of products on the market (1/01/08)

Sources: Markstudie biociden type 18, OIVO-CRIOC 2007.

At the 1/01/08, 204 products are authorized in Belgium.
A market study of the PT18 made in 2007 (available on the website of PRPB) gives the following conclusions.
The PT18 biocides are mostly bought in the summer and the market fluctuates strongly from year to year. The offer of product varies strongly between winter and summer. In the winter the offer is limited while in the summer it is extended using displays. It is hard for the consumer to find information on the sustainable use of insecticides. Around 50% of the products which have an authorisation are found on the Belgian market. This comes down to more than 100 products.
The biggest market share is taken by the products for use in and around the house. They take 90% of the market in sold products and almost 80% of the market in active substances. Especially vaporizers and sprays are popular with the consumer. The market is controlled by two trademarks, Baygon and Vapona, which each control more then 40% of the market in products for use in and around the house.
The sector of the anti-parasites has a market share of around 10%. This sector is controlled by Beaphar who control 70% of the total market. The professional sector has a limited market share when looked at the amount of sold products but takes more then 10% of the market in active substances. Most of the professional products are used by professional exterminators. Public services take a smaller part of the market.
Compared to the sector of the agriculture the use of biocides type 18 is very limited, despite a turnover of 15 to 20 million € and almost 5 million sold products. Fluctuations caused by the weather conditions make the market unpredictable and can cause a change in sales of up to 25%.

a) Active substance

Sources: authorized biocidal products (SPF, 1/01/08), actes d’autorisation, fiches techniques produits. Health and environmental effects of pesticides and PT18 biocides (HEEPEBI), PRPB 2006.

The figure 9 shows the proportion of products which contains 1 or more active substances.

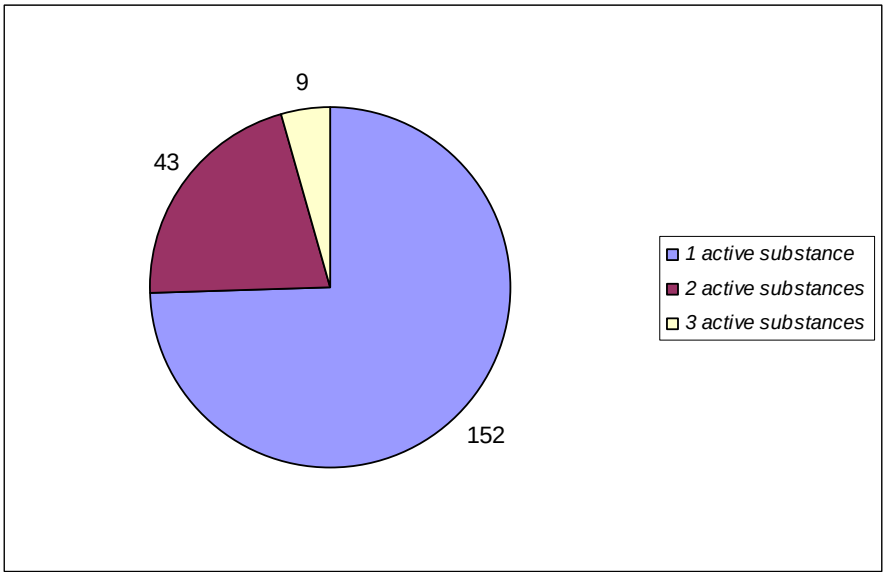


Figure 9: Number of products with 1, 2 or 3 active substances

The figures 10 to 12, present the different associations of active substances for product containing 1, 2 and 3 active substances.

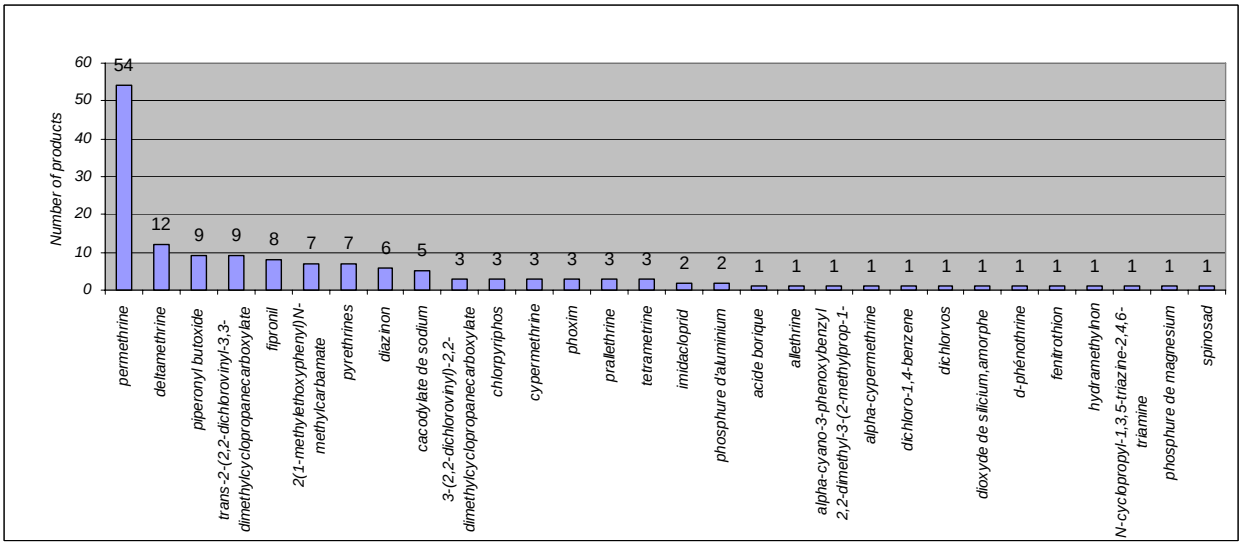


Figure 10: Active substances in product with 1 active substance (152 products)

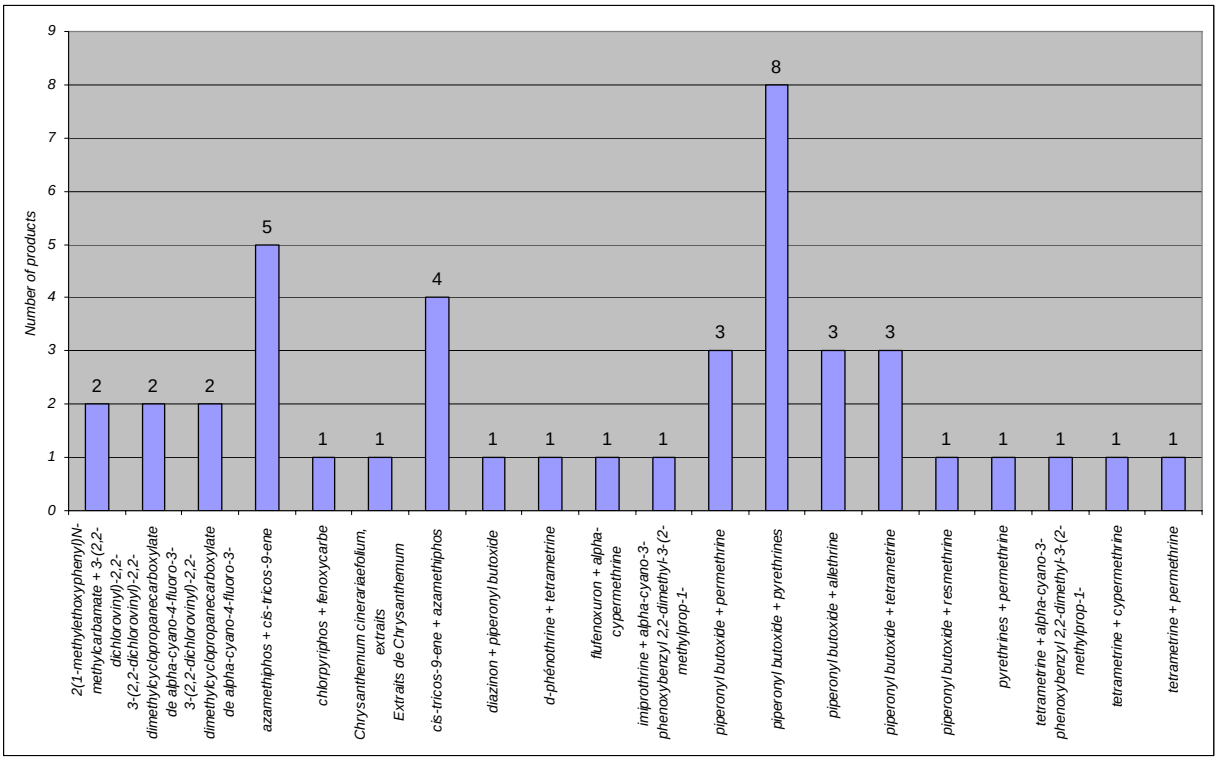


Figure 11: Active substances in product with 2 active substances (43 products)

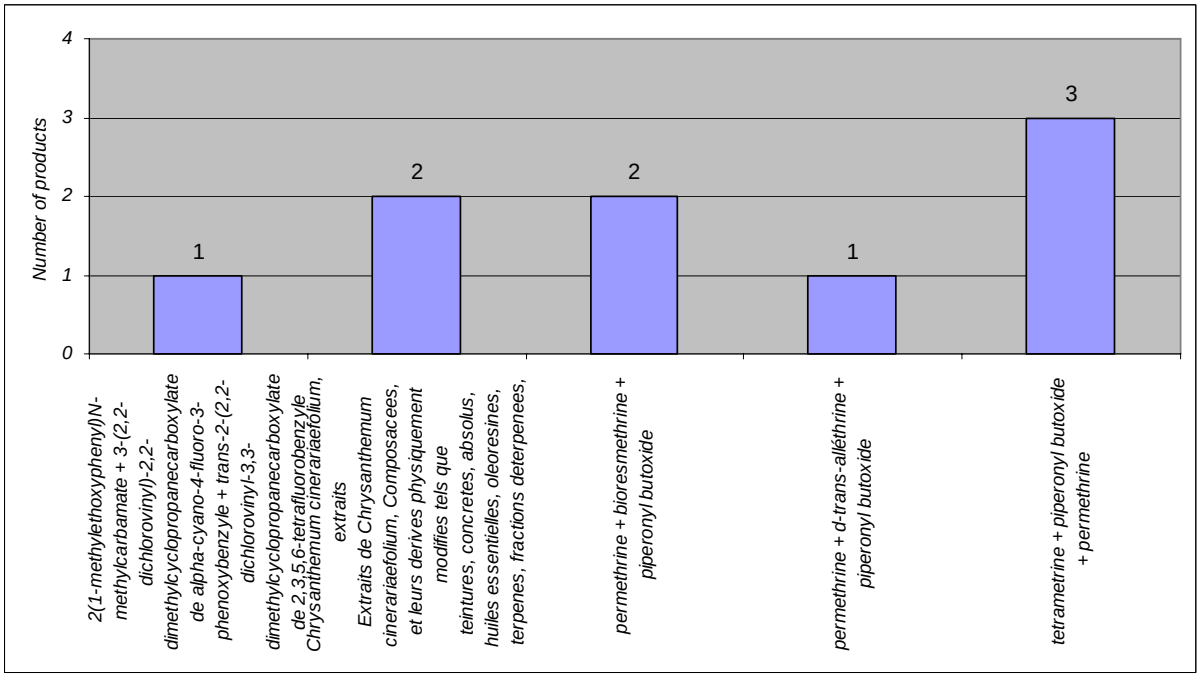


Figure 12: Active substances in product with 3 active substances (9 products)

40 active substances are identified for PT18 biocides, they are listed in the table 11. They are divided into 3 groups:

- active substances which are found in more than 10 commercial products;
- active substances which are found in 3 to 10 commercial products;
- active substances which are found in less than 3 commercial products.

Table 11: Actives substances for PT18

Active substances found in more than 10 products	Active substance found in 3 to 10 products	Active substances found in less than 3 products
trans-2-(2,2-dichlorovinyl-3,3-dimethylcyclopropanecarboxylate de 2,3,5,6-tetrafluorobenzyle	alpha-cyano-3-phenoxybenzyl 2,2-dimethyl-3-(2-methylprop-1-enyl)cyclopropanecarboxylate	acide borique
deltamethrine	Chrysanthemum cinerariaefolium, extraits	dichloro-1,4-benzene
tetrametrine	Extraits de Chrysanthemum cinerariaefolium,	dichlorvos
pyrethrines	Composacees, et leurs derives physiquement	dioxyde de
piperonyl butoxide	modifies tels que teintures, concretes, absolus,	silicium,amorphe
permethrine	huiles essentielles, oleoresines, terpenes, fractions	d-trans-alléthrine
	deterpenees, distillat	fenitrothion
	Phoxim	fenoxycarbe
	Allethrine	flufenoxuron
	Chlorpyriphos	hydramethylnon
	Cypermethrine	imiprothrine
	cacodylate de sodium	N-cyclopropyl-1,3,5-triazine-2,4,6-triamine
	Diazinon	phosphure d'aluminium
	Fipronil	phosphure de magnesium
	Azamethiphos	resmethrine
	cis-tricos-9-ene	spinosad
	2(1-methylethoxyphenyl)N-methylcarbamate	alpha-cypermethrine
	3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate de alpha-cyano-4-fluoro-3-phenoxybenzyle	bioresmethrine
		d-phénothrine
		imidacloprid
		prallethrine
		pyriproxyfen

b) Hazard classification

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

25 products belong to class A (12%).

3.3.3 Formulation

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

The products available on the market can be liquid, solid or gas. The table 12 presents the different formulation.

Table 12: Formulation (PT18)

Formulation	Formulation's code	Number of products	%
Aerosol dispenser	AE	54	27
Bait ready for use	RB	31	16
Any other liquid	AL	21	11
Antiparasite collar*	CA*	18	9
Dustable powder	DP	17	9
Liquid	LI	13	7
Wettable powder	WP	9	5
Liquid vaporize	LV	7	4
Suspension concentrate	SC	6	3
Emulsifiable concentrate	EC	4	2
Vapour releasing product	VP	4	2
Gas generating product	GE	3	2
Vaporizing mat	MV	3	2
Spot-on	SA	2	1
Water soluble granule	SG	2	1
Emulsion	EW	1	1
Hot fogging concentrate/cold fogging concentrate	HN / KN	1	1
Soluble concentrate	SL	1	1

* no specific international code exists for this formulation.

3.3.4 Method of application

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

The methods of application mentioned in the authorization acts are:

- aerosol spraying;
- spraying;
- direct deposit of bait;
- direct deposit of bait box;
- powder application;
- vapour releasing by heating;
- diffusion;
- treatment with anti parasite collar;
- shampoo application;
- fogging;
- fumigation;
- spot application.

Regarding the authorization acts, powders can be applied by two methods of application: powder application or spraying (when diluted in water). Granule bait is applied by direct deposit of bait or by spraying (after dilution).

Table 13: Method of application (PT18)

Method of application	Number of products	%
Aerosol spraying	54	27
Spraying	34	17
Direct deposit of bait	18	9
Treatment with anti parasite collar	18	9
Powder application	17	9
Shampoo application	13	7
Direct deposit of bait box	13	7
Vapour releasing by heating	10	5
Powder application / Spraying	8	4
Diffusion	4	2
Fumigation	3	2
Fogging	2	1
Spot application	2	1
Spraying / Direct deposit of bait	1	1

3.3.5 Equipment of application

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

The equipments of application which can be used for the application of product type 18 are:

- duster;
- sprayer (non professional and professional devices);
- fogger (hot and cold fogging);
- electrical diffuser (for liquid and mat);
- gel gun.

Bait box are used against ants but in this case the boxes are ready to use (sold with the gel bait inside). Thus they are not considered as equipment.

3.3.6 Field of use

Sources: authorized biocidal products (SPF, 1/01/08), authorization acts (SPF, 2008), technical sheet of products (commercial information, 2008).

The products available on the market can be used for indoor, outdoor applications or both. The treatment is done on surfaces (floor, ground, walls, room, windows, equipment….) or directly on animals (powder, collar, spot-on, shampoo). Specific products are used to treat clothes/wool.

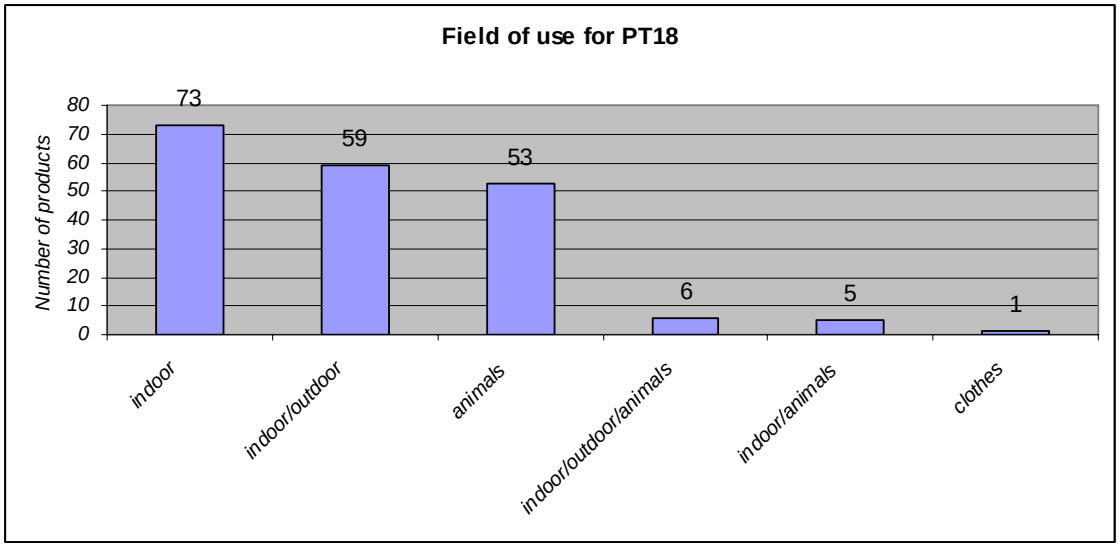


Figure 13: Field of use for PT18

3.3.7 Risk assessment

Sources :Emission scenario document for insecticides for stables and manure storage systems, OECD 2006. 4th Draft emission scenario document for PT18 for household and professional uses, OECD 2008. Health and environmental effects of pesticides and PT18 biocides (HEEPEBI)-Tasks 1 to 3, PRPB 2006.

The risks assessments are divided into the human risk assessment and the environmental risk assessment. In order to assess the risk, it is important to consider either the property of the active substance and the method of application.

a) Human risk assessment

The determination of the main routes of exposure depends on several criteria. A first step is to determine whether the product is used indoor or outdoor. Next, the formulation and the method of application will determine its most likely exposure route. For PT 18, the impact is most relevant for human health since these biocides are mainly used indoors.

Direct exposure

The **dermal exposure** has to be considered for all mixing/loading steps before application (for example products that have to be diluted before use).

All products enable **oral exposure** if they are not sealed from the environment. It has to be notice that oral exposure usually occurs accidentally and can be avoid by taking appropriate hygienic measures (washing of hands, avoid drinking/eating/smoking during application). Direct oral exposure is not considered.

Sprays, gases and formulation where the active substances are released through evaporation will result in the presence of active substances in the air, from which men and animals can be exposed through **inhalation and dermal contact**. In case of high inhalation exposure the possibility of oral exposure has to be considered (inhaled product may be transported from the respiratory tract to the gastrointestinal tract).

The inhalation exposure is higher for indoor application compared to outdoor application.

The application of powder leads to exposure by inhalation and contact. For shampoo, spot-on and collar formulations, the main route of exposure is by contact.

Secondary exposure which occurs following biocide application:

- Inhalation exposure: re-entering the treated site after fumigation.
- Dermal exposure: contact with surfaces still wet or treated with powder, contact with treated animal (collar, spot-on, powder).

- Oral exposure: For baits which are sealed from the environment, as it is the case in bait box, no exposure to man or non target animal is to be expected. But for baits not protected from the reach of men or non target animals this secondary exposure by ingestion has to be taken into account. In addition, oral exposure can occur after contact with treated surfaces (liquid, powder).

The biocide (PT18) risk for applicators (direct exposure) and for secondary exposed people (adults and children) was evaluated during the HEEPBI project (task 3 p 60-83, available on the website of PRPB). The assessment was done only for a part of the biocide PT18. Those for which emissions scenario were available: electrical evaporator, spraying, fogging, consumer spraying and dusting.
This indicator focused on human health to quantify the impact of PT18 biocides and was calculated as the ratio between exposure and effect (acceptable operator exposure level or allowable daily intake). Risk>1 implies that the target group is a risk.
All explanations about the calculations, assumptions and limits of the method are given in the report.
It was conclude that for most of the products, none of the target groups are at risk. The products which, according to the risk indicator, pose a risk to one or more target groups are listed in the report (9 products out of 69).
It seems that no link appears between a specific method of application and the risk. The influence of the active substance is important too: low AOEL (Acceptable Operator Exposure Level) value or high vapour pressure which leads to a high saturated air concentration (inhalation exposure). Concerning the method of application the duration of treatment has an influence on the risk indicator. The more the duration is, the more the deposit concentration is and thus the secondary exposure by contact increase. This is also observed for direct exposure (applicator) when a long duration of treatment by spraying is associated with a high vapour pressure or a low AOEL value.

b) Environmental risk assessment
Biocides PT18 use indoor will not reach directly the environmental compartment. Therefore, indoor receiving materials will be considered as intermediate compartments (floor, wall…). Most surfaces will be cleaned and the cleaning step will lead to releases in the environment. The final environmental compartment will be water, surface water and groundwater, the soil and the outdoor air.
The environment compartments that have to be considered are:

- outdoor air during application process: fumigation, fogging, vaporizing products or aerosol spraying. The emission in the air depends also on the vapour pressure of the product;
- waste water compartment for all application except application on animals (collar, spot-on, powder, aerosol spraying) and mixing/loading step;
- soil: through spreading of manure (products against flies and larvicides on manure) or sludge (from sewage treatment plant). Application of product directly on the soil (powder application, spraying, aerosol spraying, bait). The emissions on the soil compartment are linked to the water solubility of the product.

Emissions scenarios are available for PT18 for household and professional uses (draft) and also in the specific case of application in stable and manure storage systems.

4- Database

4.1- Structure of the database

3 databases were created in Access, one for each biocide type (wood preservatives, rodenticides and insecticides, acaricides and products used to fight against the arthropods). They are delivered with this report.
Access database are composed of several parts: table, request, form, state, macro. The table part contains all the data, the request part allows to find information inside one or more table by using the links between tables. The form part is used to create forms which will be used as interface for the user (menu, form for encoding new information in a table…). The states describe information coming from tables or from request. The macro part contains instructions used in all other parts (should not be modified by the database's user).

Each database contains information about the authorized biocides the 01/01/2008 and is composed of 5 main tables:

- table product: contains information about product authorized on the market (commercial name, number of authorization, formulation, holder, actives substances, concentrations…);
- table formulation : gives the name of formulation (French, English), definition and international code of formulation;
- table method of application : contains all information about the methods of application (name, preparation, description, user, PPE, location, pictures, equipment of application, comments….);
- table equipment of application : contains all information about the equipments of application (name, description, pictures,….);
- table contact : gives the list of contact people (name, company, type, mail, address, …).

Then, 4 secondary tables were built in order to link the main tables:

- link between equipments of application and contact (link_contact_equipment);
- link between methods of application and contact (link_methodapp_contact);
- link between methods of application and equipment of application (link_methodapp_equipment);
- link between products and methods of application (link_product_methodapplication).

The relations between the different tables are presented in the figure 14.

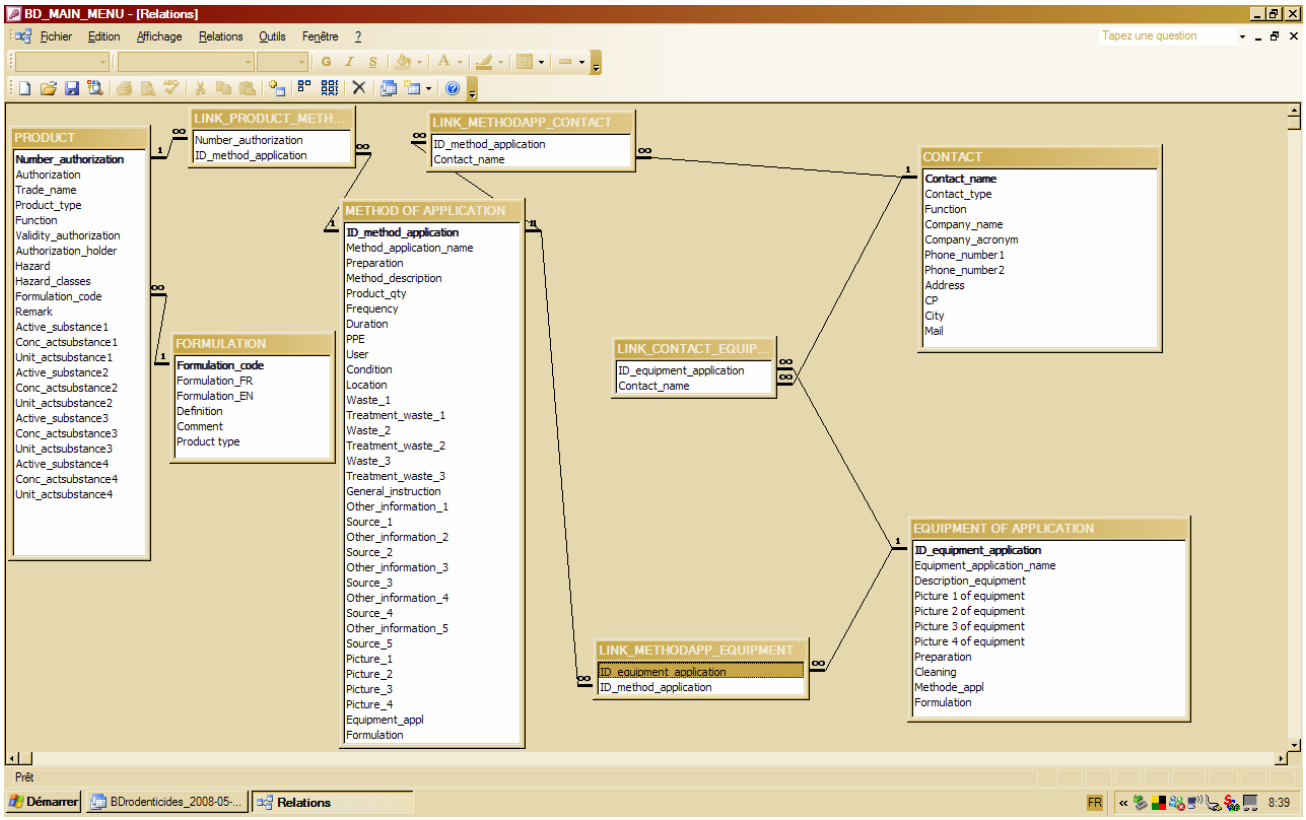


Figure 14: Structure of the database and relations between tables (for PT14 database)

4.1.1 Requests

The request part contains several requests allowing preparation of the states. Some basic requests are also prepared to describe the data:

- Active substance Requête;
- Contact_equipmentapplication Requête;
- Contact_methodapplication Requête;
- Formulation_equipmentapplication Requête;
- Formulation_methodapplication Requête;
- Hazard classes Requête;
- Waste_methodapplication Requête.

Because some requests are used for the preparation of states, it is not recommended to modify the existing ones. If needed, it is preferable to create a new request.

4.1.2 Forms

The forms are the interfaces between user and the database. 3 forms are created, 1 for the main menu (choice between method and equipment of application) and 2 others depending on the user's choice. The existing forms should not be modified by the user of the database.

4.1.3 States

The states allow presenting the data in a specific format and can be print by the user. The existing states should not be modified by the user of the database.

4.2- Using the database

As explained before, the user should not modified existing forms, macros or states. The database is a tool and was developed in order the user can have access to information very easily.

When opening the database the main menu (see figure 15) appears directly.

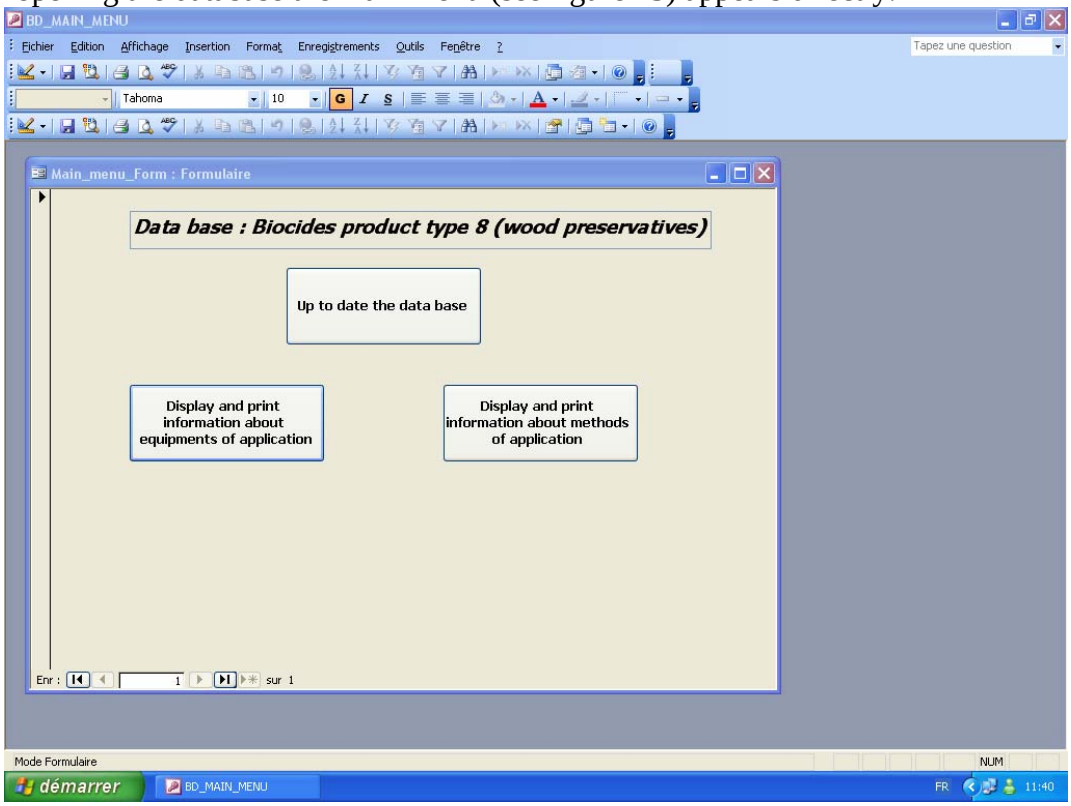


Figure 15: Main menu of the database

The user has the choice between method of application and equipment of application.

4.2.1 Equipment of application

The menu equipment of application (see figure 16) allows displaying or printing:

- description of all equipment of application
- contacts for all equipment of application

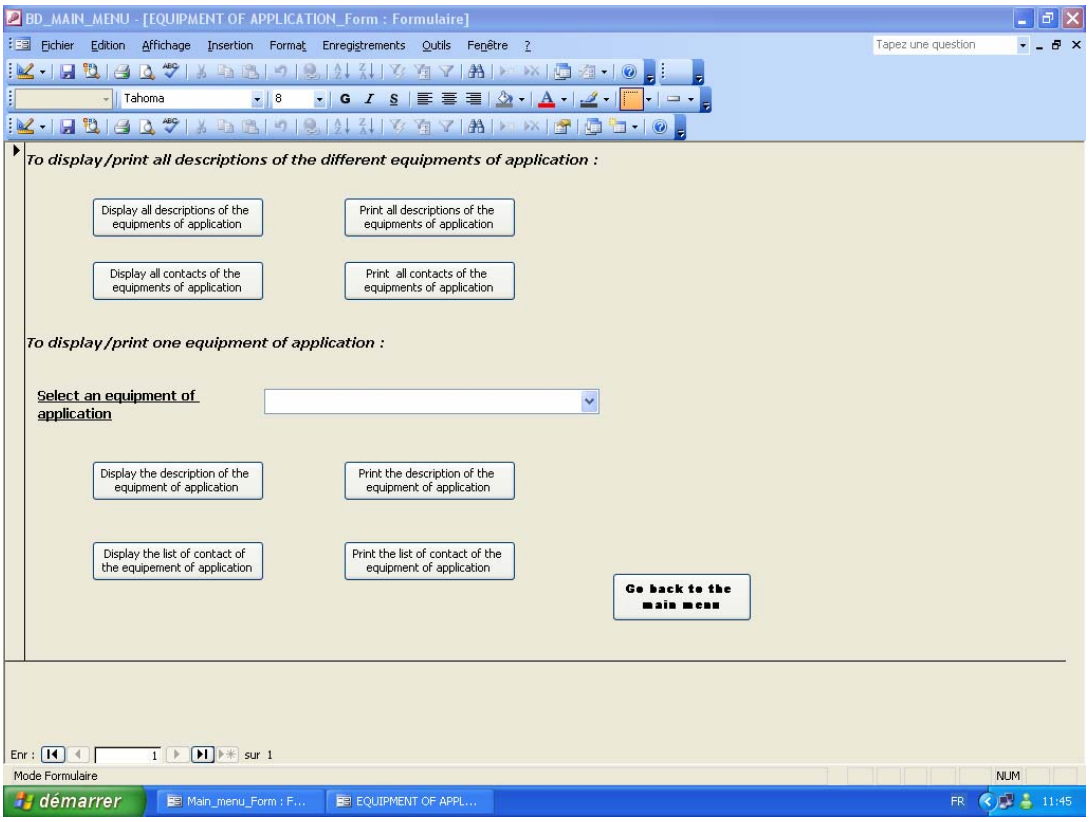


Figure 16: Menu "equipment of application"

It is also possible to select one single equipment in the list (figure 17) and display/print the description and the contacts for this specific equipment.

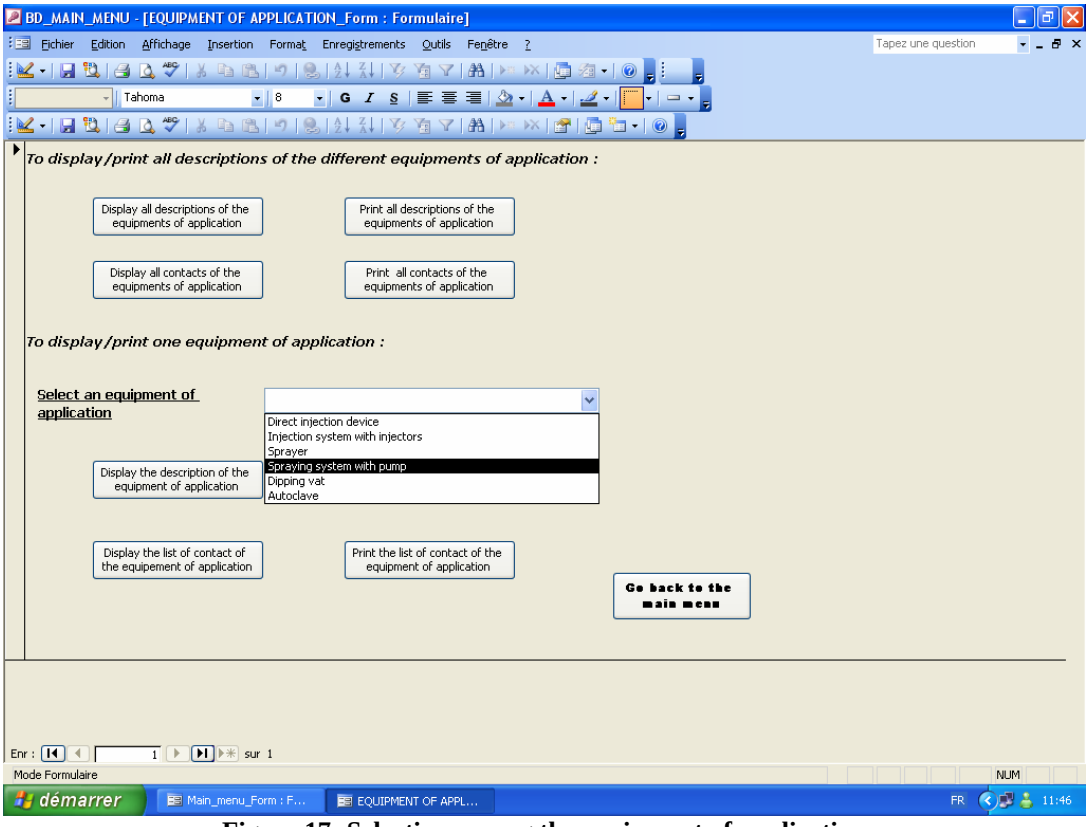


Figure 17: Selection among the equipment of application

4.2.2 Method of application

Concerning the method of application (see figure 18). The menu is almost the same as for equipment of application, but it is also possible to display/print the list of waste generated by the method of application.

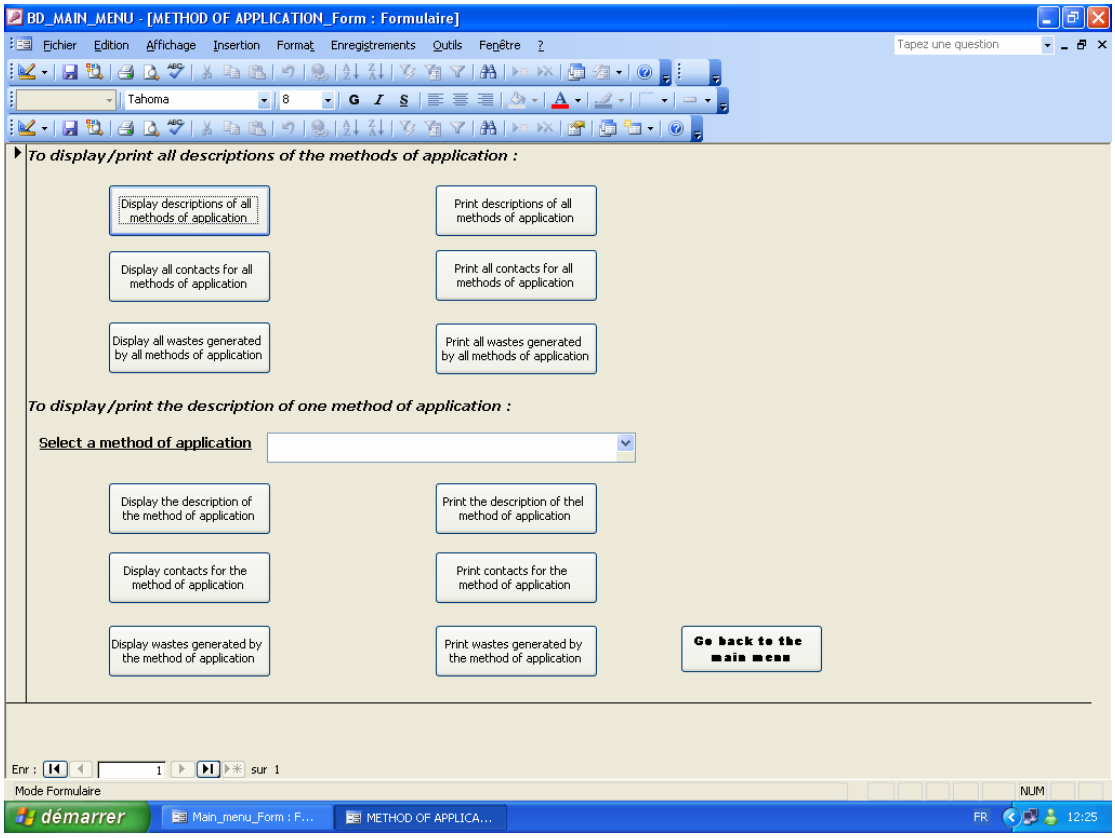


Figure 18: Menu "Method of application"

5- Prospects

5.1- Wood preservatives (PT8)

5.1.1 Research

The following table presents the main Belgian institutes working in the field of wood technology.

Table 14: List of institutes working on the field of wood technology

Institute	Research/action	Contact
Research centre of Nature, Forest and Wood	Wood technology: improve the woody production and rational use of wood	Benoît Jourez
Laboratory of wood Technology	Research project on wood technology and support to university. Development of new standardized tests for wood durability, fungi, and specific impregnation system.	Marc Stevens
Belgian Institute for wood technology	Assistance with industry (technological guidance for the innovation of the products or process and assistance safety, standardization, etc). Obligatory and voluntary certification (with the introduction of many news standards). Collective and individual research.	Marc Van Leemput (preservation)
Gembloux agricultural University-Unit of forest management	Project of research on wood technology and support to university.	Jacques Herbert
University of Louvain-la-Neuve – Unit of forest	Project of research on wood technology and support to university.	Thomas Avella

The list gives example of recent project concerning the wood preservation:

- *Microwaves treatment of woody material,* 2004-2006. Responsible for the project: Research centre of nature, forest and wood.

The FAO Directive NIMP 15 (International standards for Plant health Measurements) about the treatment of the wood packaging intended for the international business mentions that the treatment by microwaves against insects will have the possibility of being approved when relevant data will be available. Accordingly, a project of protocol for experimental tests was written by the Management of Technology of the Wood of the CRNFB in collaboration with the Gembloux agricultural university and the University of Louvain-la-Neuve and the Microwave Energy Applications Company (MEAC).

The protocol developed aims at collecting first results for the effectiveness of the treatment by microwaves to destroy the larvae of Hylotrupes bajulus L. (Capricorn beetle) in pieces of wood (CRNFB has the only breeding of capricorn in Belgium). The tests attempt to check that the temperature of wood surface can be used like parameter to control the effectiveness of the treatment. Research also aims at making sure that the parameters of treatment are compatible with the integration of the system in an industrial line production.

- *Improvement of wood product properties by increased hydrophobicity obtained by the use of silicon compounds (Hydrophob),* 2003-2007. Coordination Antti Nurmi VTT Finland, Belgian partner: laboratory of wood technology.

The project aims to develop silicon-based hydrophobisation treatments to improve wood properties in many ways, such as improved dimensional stability, durability against bio-organisms and applicability of various components to fit-to-purpose end uses. These treated and hydrophobic components will be safe to handle, environmentally acceptable and will not produce hazardous waste. The expected results are a better understanding of preventative mechanisms and the promotion of the use of hydrophobisited European-grown softwood, instead of tropical hardwoods, for value added markets.

- *Wood protection by an internally grafted polymeric film,* 2001-2003. (Responsible for the project: University of Louvain-la-Neuve, Unit of Forest).

Development of an internal-grafting process on the wood in order to reduce the moisture exchanges and to enhance the durability.

- *Wood modification, the novel base providing materials with superior qualities without toxic residues*. Thematic work, 1998-2002. (coordination of the project Holger Militz, wood technology section Wageningen. Belgian Partner laboratory of wood technology).

Wood modification will provide the world with a completely novel base material with many of the superior properties of both wood and plastics but without any toxic residue. Sustainable, fast growing European wood and fibres are the raw materials for the processes. High quality wood will be a valuable replacement for tropical hardwood, lower grades are turned into durable timber and wood-based products. Modification will double or triple the service life-time of valuable timber construction and consequently reduce the use of raw material by 50% to 70% as well as the need for maintenance by painting. Several European initiatives at various stages of development predict an enormous market potential. Cross fertilisation of all partners in the whole value-chain will lead to a tremendous step forward in this technology. Self-sufficiency of the EU in high quality base material production will be achieved. This project was following by the first European conference on wood modification; all information can be found in the proceedings of the first European Conference on wood modification, Ghent Belgium, 2003.

- *Surfasam project*, 2005-2008 (scientific coordination of the project Carlo Vaca-Garcia, ENSIACET-INP, Laboratory of agro industry chemistry, France)

The objective of the European Union “Surfasam” programme (2005-2008) was to develop an alternative to creosotes and chromium, copper and arsenic cocktails. Surfasam is a collective research programme which associates representatives of 100 small and medium sizes companies in the timber industry from numerous European countries.
Surfasam European project (www.surfasam.com) which aims to develop the masa method (see 5.1.3) for wood of class 4 and to transfer the technology with the training of managers to use new product. The idea is to prepare the commercial development of the method. The results are not available before the final meeting (will be held in July) and will be partly published on the project website at least in September 2008. According to the scientific coordinator of the project (personal communication, 2008), the objectives of the project are achieved and the results are very promising. Industrial realizations are already planned.

Additionally it has to be mentioned that 4 areas of research were suggested by the work group of PRPB:
- definition and quantification of indicators for wood preservatives in order to assess the risks for health and environment;
- evaluation and testing of alternatives products;
- development of clean processes to eliminate treated wood;
- development of rapid tests to detect presence of wood preservative in wood and to measure their fixing.

5.1.2 Market trend

a) Products
Concerning the products, the main modification on the market will be the banning of creosotes and chromium, bore and arsenic (already forbidden in Belgium) based products in Europe.
Solvent based product are less and less used and replaced by water based products for non professional and professional use.
According to the CTIB (activity report 2007), the change started since a few years aiming at replacing the preservatives "traditional" by formulations of aqueous the dispersions type still intensified in 2007. This movement is supplied with the request of the companies working under technical approval TGA, which see in these new formulations the means of offering safe treatment and fulfilling the most pointed requirements as regards protection of the users and the environment.

b) Method of application
In Belgium the industrial spraying isn't use anymore (personal communication Marc Van Leemput, 2008) because the same level of utilization class can be obtained by dipping. The vacuum/pressure process is not very use in Belgium (only one technical approval).
Due to the banning of creosotes and chromium/bore based products, new treatments will probably be developed: heat treatment, masa impregnation, oleothermic process (see 5.1.3).

c) Review of technical approval
The technical approvals are currently reviewed by the CTIB (Marc Van Leemput, 2008). At the moment only a draft version is available.
The certification of the wood industries began again with the current of 2007, whereas the request had been nonexistent in 2006, and this tendency seems to continue for 2008. It is a strong signal showing that the companies are conscious of the importance of being able to offer to their customers a guarantee of results, based to objective and independent measures. (Activity report, CTIB 2007).
Technical approvals are not given anymore for short dipping process (3 minutes) due to observed practices which have shown that the average duration of dipping was less than 3 minutes.

5.1.3 Non chemical alternatives

a) Choice of the wood species
The first measurement aiming at limiting the treatments is to choose a specie naturally adapted to the use of wood in term of class of natural durability and sensitivity to the attack of insects and fungi (for further details see Guide la préservation du bois, CTBA 1998).

b) Heat treatment

There exist several processes of heat treatment. This type of treatment allows an improvement of resistance to fungi without the addition of chemical molecules. One of the large assets is the dimensional stability which is improved. These treatments involve the destruction of the natural substances contained in wood which are used as food for the biological agents. According to the PRPB- Work group wood preservatives (2006), these treatments require an important contribution of energy, the behaviour of the treated wood placed in contact with the ground is bad and its resistance to the termites is discussed. Wood treated change colour and the shock resistance is decreased.

Some examples of heat treatments are presented below.

See also the review on heat treatments of wood, proceedings of special seminar held in Antibes, 9 February 2001 (http://www.dgfh.de/pdf/review_heat.pdf).

Thermowood® (for further details see Thermowood handbook, Finnish Thermowood association, 2003 – www.thermowood.fi)

Thermowood is manufactured using a method developed by VTT. The wood material is heated to a temperature of at least 180°C while it is protected with steam. Besides providing protection, the steam also affects the chemical changes taking place in the wood. Its colour darkens, it is more stable than normal wood in conditions of changing humidity, and its thermal insulation properties are improved. If carried out at a sufficiently high temperature, treatment also makes the wood resistant to decay. On the other hand, this has a decrease in the bending strength.

Retification®

(http://www.emse.fr/fr/transfert/spin/depscientifiques/PC2M/retification).

In the first phase of the treatment, the wood will be dry, until temperatures ranging between 160°C and 180°C. At this stage, wood is not deeply modified and its state is reversible. Beyond this point, the modifications of wood will be final. The parameters of colour, stability, and finally of durability of the starting wood will move gradually. One of specificities of the retification is to work at temperatures constituting the “phase of vitreous transition”. To reach these temperatures, specific to each species, wood must be carried at temperatures being able to reach 240°C. Once the temperature of peak reached, wood are cooled by watering. They return gradually to room temperature, to which they will keep the properties of stability and durability acquired at high temperature. The presence of oxygen during the temperature treatment degrades considerably the mechanical properties of wood; this is why the retification is held in inert atmosphere, without oxygen (example of application www.retiwood.com).

Plato® process (www.platowood.nl)

This process is a pressure, heat process. It consists on a dry and wet process stage executed at relatively high temperatures (160-180°C). The first stage of the process is done at high pressure in a saturated ambiance. This results in a chemical modification of the main wood components (especially lignin and hemicelluloses) affecting the mechanical properties of wood.

WTT heat treatment plant (www.wtt.dk), **Perdure®** (www.perdure.com)...

c) Oleothermic process

Inspired of a traditional method associating wood and plant oils, this process consists in impregnating wood of a mixture of plant oils and natural additives heated at low temperature (<150°C). The oleothermic process was developed by CNRS and the CIRAD.

It breaks up into three distinct phases which ensure each one a different function. The first step of heating vaporizes the water of wood. Wood is plunge in a first oil bath at approximately 120°C. The second step, carried out in a different oil bath, condenses the steam what generates an in-depth penetration of oil in wood. After draining, the phase of air drying finalizes the impregnation.

Figure 19: Unit of oleothermic process (www.oleothermie.fr)

The main advantages of the process mentioned are, in addition to the improvement of resistance to the degrading agents, an improved dimensional stability and a delayed appearance of the greyness colour. Further tests must be carried out in order to confirm these information.

d) Masa process, wood protect®

The wood is treated with masa. Masa (Methyl Alkenoate Succinic Anhydride) is a non toxic compound, which is a derivative of rapeseed oil. During wood treatment, masa transforms cellulose into a cellulose ester that timber-boring insects cannot consume because they do not have appropriate digestive enzymes. Thus Masa is not an insecticide, but acts by depriving insects of their food, cellulose. The second beneficial effect of Masa on the wood is that it reduces the risk of mould. During treatment, the oily Masa solution fills the wood alveoli and prevents swelling, due to its hydrophobic properties. Thanks to these properties, treatment with Masa currently provides wood with class 3 protection (no contact with the soil). Research is being pursued in order to achieve the highest level of biological protection, class risk 4, meaning protection for timber in contact with the soil. The impregnation takes place in two steps. First, a vacuum/pressure process in autoclave. During the second step, the wood is plunged into a bath of masa heated at 140°C.

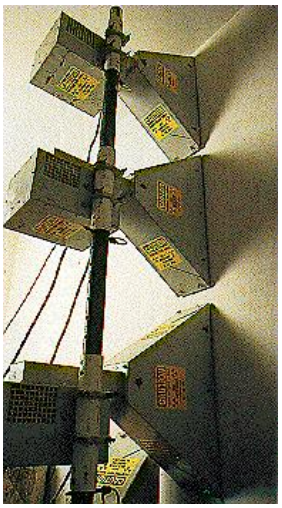
This method was also developed in association with Lapeyre (wood protect®) industries to treat wood used for windows and shutters. For more information see www.inra.fr, http://ec.europa.eu/environment/etap

Figure 20: Autoclave for the masa process (www.inra.fr)

e) Other chemical modification processes

A complete review of wood modification is given in Wood modification developments Horman, Jorissen 2004). http://heron.tudelft.nl/2004_4/Art5.pdf

f) Microwaves treatment



This method is used for termite's control (spot application). Microwaves kill termites by causing fluids inside their cells to boil, which destroy cell membranes. There are a number of firm in United States offering microwaves treatments. One advantage of microwaves is their relative portability. When using microwaves, however, detection accuracy is critical to success. Microwaves treatment may damage the surface or interior of wood boards, depending on the power of the device (the wattage or power of microwave or heating devices may vary from several hundred to more than 10,000 watts.) Lab studies revealed no relationship between increasing microwave wattage and termite mortality. As with heat treatments, it may be difficult to heat areas with heat sinks to high enough temperatures with microwaves for effective control (www.ipm.ucdavis.edu).

Figure 21: Microwaves treatment www.utoronto.ca

The utilization of microwaves against capricorn beetle has been studied in Belgium in the frame of a specific project (Microwaves treatment of woody material, CRNFB). The aim was to collect information about the feasibility of such a treatment for the wood packaging in case of international commercial exchange. The preliminary results show the effectiveness of the microwaves treatment but complementary tests are necessary to try to reduce the time of the treatment authorizing the integration of the system in an industrial line production. The effect of the wood load inside the microwave oven and the profitability of the process must be studied. The report is confidential but a publication is on the way (more information contact Research centre of Nature, Forest and Wood).

It has to be mentioned that devices producing electric field are also used against termites.

f) Controlled atmosphere technology
This technology is used in the case of curative treatment of antiques or objects from museum. The furniture is placed in an airtight environment and CO_2 or N_2 is injected. This allows eradicating insects, grubs and eggs without damages to the wood (no holes for injection or stains due to product). One example of application can be found at Rentokil pest control.

Figure 22: Controlled atmosphere technology (Rentokil)

g) Non biocidal products
Some products biocide free are available on the market like Wood bliss or Biofa Nahos (www.biofa.de). These products are used for the treatment of wood used indoor and are suitable for protecting wood from insects and fungi. These products are silicate based and need to be further evaluated regarding the behaviour of the treated wood during the time.

5.2- Rodenticides (PT14)

5.2.1 Research

The following table presents the main Belgian institutes involve in the rodent control action or research.

Table 15: Institutes working in the field of rodent control

Institute	Research/action	Contact
Agricultural Research Center of Wallonia (CRA-W) Department of biological control and plant genetic resources	Several tests and project in support of the rodent control section in Wallonia. Breeding of rodents.	Pierre Joye
Department of pesticides research	Efficacy studies on rodenticides. Breeding of rodents.	Michel De Proft
Research institute for Nature and Forestry	Several tests and project in support of the rodent control section in Flanders.	Jan Stuyck Kristof Baert
Ministry of the Walloon Region- General Directorate for Natural resources and the Environment	Muskrat control in Walloon Region	Stephan Adam
Ministry of the Flemish Region- Afdeling water	Muskrat control in Flemish Region	Marc van der Weeen

The Department of biological control and plant genetic makes applied research on control of muskrat: comparison of different method for rodent control, study of the secondary poisoning of birds and mammals with rodenticides of first and second generation. At the moment, a survey is made about the rodent control in the Walloon communes.

The aim is to have information about the method use, the product use, the problems encountered and the formation, in order to set up a global politic for the rodent control (for example lack of training, specifications for rodent control…). It is also planned to make a study to compare the appetency of several baits available on the market (end of 2008).

The Research institute for nature and forestry supports the Flemish rodent control actions (communication of Jan Stuyck). In the past a lot of research on muskrat and coypu control was done: chlorophacinon baiting and trapping techniques, work organization, efficiency…At the moment the main focus is on different aspects of brown rat control. The research topics are:

- Ecology of the rodents in order to improve the integrated pest management, to understand the dispersal and the population ecology.
- Rodenticides. Comparative palatability of baits, resistance (mutation and practical resistance), incidence and distribution of the resistance levels in Flanders.
- Rodent control. Bait uptake in the field, selectivity, bait boxes, intoxication, efficacy of control measures and baiting regimes.

The working group of the Federal program of pesticides and biocides reduction has recommended in 2006 to make a survey in Belgium with an aim to characterize geographically the state of the resistance of the rodents to the anticoagulants.

5.2.2 Market trend

For non professional application, the trend is to reduce manipulation of the product with the utilization of bait ready for use. Some products are even sold in bait boxes. Bait boxes very easy to build are available.
The professional stress more and more the preventive fights and the proof buildings and propose contract in this direction with for example the installation of systems of detection of the rodents before the curative treatments (restaurants, agro food industries, laboratories…).
According to the MRW, the number of available product will certainly decrease when the pesticides authorization will end. Especially the first generation of active substances which are less and less used (resistance and slower effect).
In practical conditions it has to be mentioned that phostoxin products (with aluminium phosphide) which are very toxics, are not use by professional for rodent control.

5.2.3 Non chemical alternatives

Non chemical alternatives exist to fight against the rodents. The preventive methods and the curative methods are distinguished. These methods are more or less adapted according to the target species, the area and the infestation.

a) Preventive measures
In order to limit or avoid the use of chemical molecules it is important to consider a whole series of preventive measures. These measures aim preventing the intrusion of the rodents in buildings, working areas or storage or at limiting the places favourable to the rodents.

Rodent-proof construction
When the presence of the rodents poses a problem inside building, the first measurement is to prevent the intrusion.
Correctly built and well maintained buildings constitute the first obstacle against the rodents.

Deep foundations prevent an underground access. The holes, cracks, spaces around the windows or doors, the broken windows, the electricity or water pipelines, the ventilating system… are entrance points for the rodents. These openings must be repaired or filled up with adequate materials (no plastic or wood). For further details see Rodent-proof construction and exclusion methods Baker, Bodman and Timm, 1994. http://www.ces.ncsu.edu/nreos/wild/pdf/wildlife/RODENT_PROOF_CONSTRUCT.PDF

Cleanliness of the surroundings

In order to limit the proliferation of the rodents to the surroundings of the buildings it is important that spaces are cleared: no stacking or cumbersome object behind which the rodents can hide. The easy access to food must be limited: closed dustbins, no food losses on the ground during the food distribution…Lastly, the access to water must be prevented too. (further information : Rodent control services).

Figure 23: Examples of attracted areas for rodents (MRW)

b) Curative measures

When the rodents are present, it is possible to eliminate them without having recourse to biocides.

Trapping

In Belgium, the trapping is especially used to fight against mice, muskrats and moles. The control of the muskrat is done partly by trapping for the easy places of access (for example drains close to the roads). The brown rat which is too suspicious is difficult to trap. The traps, the nets and mousetrap are authorized.

The mechanical fight does not have any legal constraint. Only prohibition relates to detention, the sale and the offer of jaw traps, this last figure in Article 9 of the Law on Hunting (European directive 3250/91). The traps used by the regional services of rat extermination were thus transformed in order to follow this Directive. A wedge was posed in order to prevent the catch of the animal by a member or the tail. According to a personal communication of Stephan Adam (2008), a European directive project could call in question the use of the nets (too many suffering of the animal before the death). Such a regulation could call in question the fight against the muskrat in Belgium because 50% of the catches in Walloon region and 80% in Flemish region are done by nets.

Figure 24: Traps used by the Ministry of the Walloon region – control of muskrat (MRW)

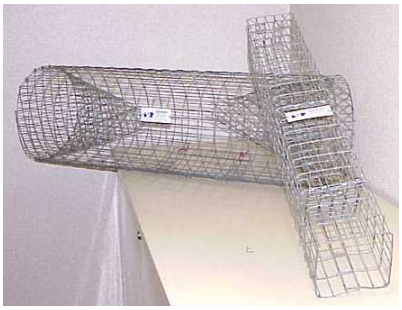


Figure 25: Nets used by the Ministry of the Walloon region – control of muskrat (MRW)

Plate with glue

The principal users are the private individuals and the professionals when the fight is done in companies subjected to standards (for example HACCP) which do not authorize the presence of biocides in the buildings.

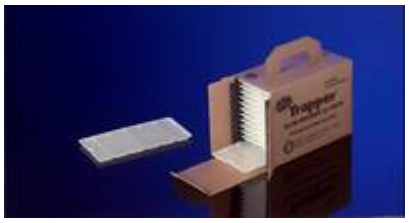


Figure 26: Plate with glue ready for use (www.edialux.be)

Figure 27: Tunnel with glue plate (www.edialux.be)

Figure 28: Glue tube (www.edialux.be)

Natural predator

It is also possible to control the proliferation of the rodents by supporting the presence of natural predator. For example in the seedbeds, by placing perches for predatory.

Repulsive with ultrasounds

These repulsive emit inaudible ultrasounds for the man and the pets which disturb the rodents. The operating range is limited and depends of the power of the apparatus. These repulsive can be used inside or outside and are fed by sector or pile. Equipments can emit variable frequency in order to avoid habituation. Anti moles are inserted in the ground.
Tests were made at CRA-W to compare the efficacy of ultrasounds repulsive, but the results were not published, only one publication mention that this type of equipment shows no significant action on rodents.

Figure 29: Ultrasonic repulsive against mice (price list Internet Kelkoo)

Figure 30: Ultrasonic repulsive against moles (price list Internet Kelkoo)

Odorous repulsive

Odorous repulsive are available on the market, they are used outside the buildings or in the gardens. There are made of inert materials impregnated with oil or wax.
There exists also repulsive filler paste used to fill up the holes caused by the rodents.
Against stones mothballs are also used as odorous repulsive.

Figure 31: Repulsive filler paste (www.edialux.be)

5.3- Insecticides, acaricides and products used to fight against arthropods (PT18)

5.3.1 Research

The research in Belgium is not specific to biocides, the institutes are working on pesticides field.

Table 16: List of Belgian institutes working on plant protection

Institute	Research/action	Contact
Agricultural Research centre of wallonia Unit of pesticides research	Efficacy test, registration of pesticides and evaluation of efficacy dossier	Bernard Weickmans, François Cors
Unit of biological control and plant genetic resources	Biological control	Marc Cavelier
University of Louvain-la-Neuve Unit of ecology and biogeography	Biological control	Thierry Hance
University of Ghent Laboratory of crop protection chemistry	Study of pesticides residues in crops and side effect of pesticides treatment. Influence of formulation and application aspects on the efficacy of pesticides treatment	Walter Steurbaut
Laboratory of phytophatology	Biological control	Monica Höfte
Institute for agricultural and fisheries research Unit plant- research area crop protection	Research on alternative pest and disease control methods, such as biological control.	Martine Maes

The developed projects are link to the alternative to pesticides use (biological control) like:

- *Control of the aphid with micro hymenopterous parasitoide* (University of Louvain-la-Neuve - ECOL, responsible Marie-Anne Legrand)

More information on: http://www.ecol.ucl.ac.be/edic/fr/hymen2.html

- *Characterization and bio control of sclerotinia spp and rhizoctonia solani in greenhouses grown lettuce* (University of Ghent- Laboratory of phytophatology)

This research is situated in a FOD-project, called 'Alternatives for the use of methyl bromide in greenhouse-grown lettuce'. Lettuce drop, caused by *Sclerotinia spp.*, and bottom rot, caused by *Rhizoctonia solani* are two important diseases in greenhouse-grown lettuce. Both pathogens can survive in soil as sclerotinia for many years. Until 2005, the control of both diseases in Belgian greenhouses was mainly based on soil fumigation with methyl bromide. Because of the ban of methyl bromide, there is a pressing need for effective alternatives. Lettuce drop can be caused by three different species of *Sclerotinia*: *Sclerotinia sclerotiorum*, *S. minor* and *S. nivalis*. *Rhizoctonia solani* is a complex species and can be subdivided in 13 anastomosis groups (AG) and subgroups. In Belgium no records are available about the possible *Sclerotinia spp.* involved in lettuce drop or about the anastomosis-groups and subgroups of *Rhizoctonia solani* causing bottom rot. Because this knowledge is important when developing an effective control strategy, the first aim of this project is to collect isolates from different greenhouses in Belgium.

These isolates are being characterized using morphological characteristics and different molecular techniques. The ultimate aim is to develop an integrated pest control. Different control strategies are being tested: antagonistic fungi and bacteria, incorporation of organic matter...

- *Antifungal activity and mode of action of Serratia plymuthica as biological control agent against Phytophthora rot and Botrytis cinerea on tomato and cucumber* (University of Ghent- Laboratory of phytophatology)

Previous studies have shown the ability of *S. plymuthica* to suppress a wide range of phytopathogenic fungi in vitro and in vivo. Current research is in its early stages and will continue to build on this knowledge. It will focus on the antifungal activity and possible multiple mechanisms of several plant-associated strains of the gram negative bacterium *Serratia plymuthica* against diseases of tomato (*Lycopersicon esculentum*) and cucumber (*Cucumis sativus*). *Serratia plymuthica* IC1270, IC14 and HRO-C48 will be tested in substrate culture and soil cultivation of both tomato and cucumber against *Phythophtora* root rot diseases. The bacterial strains will also be evaluated as possible biocontrol agents, both as foliar application and soil inoculation to induce systemic resistance in the foliar parts of the plants against *Botrytis cinerea* grey mould. More insight in the modes of action will also be pursued.

5.3.2 Market trend

For non professional application, the products sold are ready to use formulation. A description of the market can be found in Markstudie biociden type 18, OIVO-CRIOC 2007 (can be downloaded at www.prpb.be).

The professional stress more and more the preventive fights and the integrated pest management. In order to response to the banning of Methyl bromide, new products and new method of application are tested and encouraged. More information is available in the 8th fumigants and pheromones technical conference proceedings, 2007 and in the training and technical support in alternative technologies to Methyl bromide fumigation, UNEP, UNDP, 2006.

5.3.3 Non chemical alternatives

a) Trapping

The traps available on the market can be distinguished into mechanic, electric or pheromone traps. The traps are used by non professional in order to control insects in a limited area like in restaurant, in garden, in kitchen, in cowshed…They are also used into greenhouses. At larger scale (in field) they can not control infestation and are only used in order to evaluate the level of infestation (alert system, integrated control).

Mechanic traps

The mosquitoes are attracted by the heat and humidity or by a light (produced by the traps), then they are aspirate by an air flow created by a fence through openings.

Figure 32: Mosquitoes mechanical trap (JR international)

Electric traps

In electric traps insects are attracted by light through the protective grill and are electrocuted.

Figure 33: Electric trap (www.belgagri.be)

Attractive and pheromone traps

Insects are attracted into the traps by appealing food or pheromone.

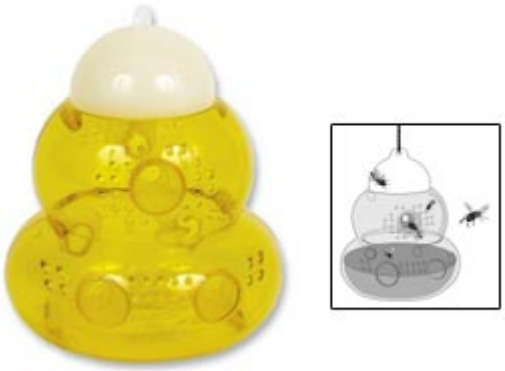


Figure 34: Traps for wasp and drosophila used with appealing food (belgagri)

Figure 35: Flies trap (étamine du lys)

Figure 36: Trap for cockroach (edialux)

Figure 37: Pheromone trap for moth (edialux)

Figure 38: Pheromone trap

Glue system

It exists several glue systems for crawling insect as for flying ones. Most often, pests are attracted by an appealing food and are sticky with glue. Some glue systems do not contain attractive food and are just placed where the insects are likely to be (like glue stickers for flies which are placed on windows). These systems can only control insects in limited area.

Figure 39: Glue systems (www.edialux.com)

Figure 40: Glue systems (www.belgagri.be)

Figure 41: Flies catcher for agricultural use (www.edialux.be)

b) Natural products/ bioinsecticides

Product with natural extracts

The more often, products contain natural pyrethrum associated with oils. It exist also products with essence seed of Neem, Margosa (tropical trees).

Bio insecticides

Bio insecticides are insecticides prepared from living organisms (like fungi, bacteria and virus) or of the substances that they produce (based on the biologic control). The bio-insecticides are very specific: each one is active only against one limited number of species.

Bacillus thuringiensis (Bt) (example of product: Xentar®WG, Scutello®2xRP, www.biobest.be) is a naturally occurring, soil borne organism. Bt is effective in controlling insects in the larva stage only. The larva stage in an insect's life cycle is the stage during which most of the feeding occurs. Since Bt must be ingested to work, the insect must be controlled during the larval stage. The Bt is applied to the foliage of plants infested with a leaf or needle eating larva. After Bt spores are ingested by larvae, they grow and reproduce, meanwhile producing crystalline toxins. The crystalline toxins paralyze the digestive tract of the larvae causing it to cease eating. Death will follow, but time of death can range anywhere from 12 hours to 5 days after ingestion. This depends on the amount of Bt ingested, the size and variety of the larvae and variety of Bt used for control. There are different strains or varieties of Bt available that have been selected for the control of specific insects. Bt variety kurstaki (BTK) controls the European corn borer, tomato hornworms, fruit worms, cabbageworm… Bt variety san diego (BTSD) controls early larvae of the Colorado potato beetle. Bt variety israelensis (BTI) controls mosquitoes, black flies and fungus gnats.

Baculoviruses are specifically pathogen of invertebrates. Each strain is specific to one or few species. After ingestion, the virus replicates himself in the intestinal track and spreads out into the insect's organism. Example of commercial products: Capex®, Madex®, Spexit®, Carpovirusine®2000 (www.biogarten.ch, www.arysta.eame.com).

Unlike bacteria and virus, *fungi* don't have to be eaten by insect pests. One single contact allows launching the infection. The fungus perforates the tegument, grows inside the insect and produce toxins and enzymes which lead to death. See www.biobest.be to have get example of products available on the market.

c) Heat treatment

The heat treatment is used in food industry (bakeries, mills, restaurants…), pet food industry, non food industry like tobacco factories, storage of cloths, hotels. In fact, when temperature has no impact on the product.

The temperature is raised to 50-60°C for duration of 24-48 h with heater equipment (heating system, fan and thermostat to monitor the temperature).

Figure 42: ThermoNox heater (www.thermonox.de)

More information is available in the 8th fumigants and pheromones technical conference proceedings, 2007 and into the ThermoNox presentation.

d) Cooling

Cooling is used for the storage of agricultural products like cereals. Below 5°C the activity of insects is stopped. The cooling can be done by a ventilation system by using the outdoor temperature (when permitted) in wintertime (as in Belgium) or by a cooler.

Figure 43: Ventilation system for wheat storage (CRA-W, 2007)

e) Fumigation

In order to response to the banning of Methyl bromide, several new products were developed as alternative for fumigation treatment.

Among these the Envirosol® product range used CO_2 as solvent-propellant for fumigation. The Pestigas® product is composed of CO_2 and natural pyrethrum and need to be further evaluated for quarantine treatment. See the 8th fumigants and pheromones technical conference proceedings, 2007.

f) Silicosec®

Silicosec® is made of diatomaceaous earth (DE). DE consists of fossilized remains of diatoms a type of hard-shelled algae (composed of silica, sodium, magnesium and iron). This powder has an abrasive feel and is used as a mechanical insecticide in grain storage.

See the 8th fumigants and pheromones technical conference proceedings, 2007. Publications were made is order to evaluate the effect of the temperature and the grain type on the efficacy of treatment. Effect of grain type on the insecticidal efficacy of SilicoSec against *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae) C. G. Athanassiou, N. G. Kavallieratos, F. C. Tsaganou, B. J. Vayias, C. B. Dimizas and C. Th. Buchelos, 2003.Effect of temperature and humidity on insecticidal effect of silicosec against Ephestia kuehniella (Lepidoptera: Pyralidae) larvae. ATHANASSIOU Christos G.; KAVALLIERATOS Nickolas G.; TSAKIRI Johanna B. XYRAFIDIS Stefan N.; VAYIAS Basileios J., 2006. Factors affecting the insecticidal efficacy of the diatomaceous earth formulation SilicoSec® against adults of the rice weevil, Sitophilus oryzae (L.) (Coleoptera: Curculionidae) ATHANASSIOU Christos G. ; KAVALLIERATOS Nickolas G. ; DIMIZAS Constantin B. ; VAYIAS Basileios J. ; TOMANOVIC Zeljko ; 2006.