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**Use of medical drugs against varroosis**

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**ABSTRACT**

A review on medical drugs currently available for varroosis control is given. Different approaches are considered according to broodright and broodless colony conditions and to the different impact that a treatment could have on the colonies and beehive products. Resistance development linked to varroosis control is also considered.

**Keywords:** *acaricides, essential oils, honey bee, organic acids, residues, Varroa destructor*

**INTRODUCTION**

In Europe different climatic conditions occur, which are characterised by the presence of brood in spring-summer and broodless conditions during winter in the centre and north, as well as continued presence of brood throughout the year in the south. Intermediate conditions also exist.

However, a consistent reduction of brood is usually recorded during the summer in very hot climates. In these situations, acaricides usually advised for autumn-winter may be applied in summer. Due to the variation in presence of brood at least two different strategies against Varroa are required.

Reinvasion of mites into treated colonies from untreated colonies is a major problem in Varroa control. The treatments against the mite should be coordinated by Health Authorities in collaboration with the local beekeepers' associations. In order to avoid the reinfestation of treated colonies, the same application times and techniques should be used in the same area.

Simplicity, low cost and labourlessness of treatments are crucial features of the strategy in order to involve as many beekeepers as possible in these coordinated programmes.

None of the presently available techniques allows the colony survival by a single application, except for northern regions characterised by long broodless periods and low infestation levels.

Furthermore, the widespread use of the traditional chemical control of varroosis led to the presence of residues of active ingredients in honey, wax and other beehive products as well as to the development of pharmacoresistance.

This note summarises the possible traditional chemical and integrated control methods that are available for controlling Varroa-mites infestation.

## TRADITIONAL CHEMICAL TREATMENTS

The traditional chemical treatments used against Varroa-destroyer in Europe are listed with information on their use, efficacy, safety for bees and bee products, and pharmacoresistance.

Usually, the application of the following acaricides according to the instructions for use is sufficient for a good control of mite infestation.

Interventions not requiring chemical substances, such as drone brood removal has limited efficacy and should be followed by chemical treatments.

A huge list of chemical products has been used in the attempt to control Varroa-mite infestation in honey bee colonies since its first appearance in Europe at the end of the '70s. When considering active ingredients for varroosis control, one should consider the following features:

- *time of use*: broodright colonies and broodless colonies;
- *mechanism of action*: evaporation, contact, systemic;
- *way of administration*: trickling, inert vehicle (tablets, sponge, strips).

### BROODRIGHT COLONIES

Apistan<sup>®</sup> (Vita Europe)

A.I.: fluvalinate

Easy administration: 2 strips/6-10 weeks

High efficacy (95-99%) until 1992

Resistance to pyrethroids (Spreafico et al., 1993)

Not toxic

Residues: wax

No withdrawal time

MRL: not subject

Bayvarol<sup>®</sup> (Bayer)

A.I.: flumethrine

Easy administration: 4 strips/6-10 weeks

High efficacy (95-99%) until 1992

Resistance to pyrethroids

Not toxic

Residues: wax

No withdrawal time

MRL: not subject

Fluvalinate, flumethrine, thymol, menthol, eucalyptol, camphor, formic acid, lactic acid are included in Annex II to the Council Regulation (EEC) 2377/90 laying down a Community procedure for the establishment of maximum residue limits of veterinary medicinal products in foodstuffs of animal origin. As a consequence they are not subject to MRL (Maximum Residues Limit).

Traditional chemical compounds such as pyrethroids usually have a positive impact on beekeepers since no visible negative effects on honey bees and their products as well as no relevant reactions of honeybees to their administration is observed.

Broodless colonies

### **Perizin<sup>®</sup> (Bayer)**

A.I.: coumaphos, phosphoric compound

High efficacy

Easy administration: 5 ml/bee way (trickling on the bees)

Pharmacoresistance: first report in Lombardia, Italy (Sprerafico et al., 2001)

Toxic: bees

Residues: wax

Withdrawal time: 42 days

MRL: 100 ppb (Annex I)

### **Apitol<sup>®</sup> (Vita Europe)**

A.I.: cymiazole

High efficacy

Administration: 100 ml of water-sugar solution (20%)/bee way (trickling on the bees), repeat once at 1 week interval

Pharmacoresistance: not reported

Highly toxic: bees

Residues: honey

Withdrawal time: 90 days

MRL: 1000 ppb (Annex I)

### **Apivar<sup>®</sup> (Novartis)**

A.I.: amitraz

High efficacy: broodless colonies

Easy administration: 2 strips/10-12 weeks

Pharmacoresistance: well known

Not toxic

Residues: honey

No withdrawal time

MRL: 200 ppb (Annex I)

Coumaphos, cymiazole, amitraz are included in Annex I to the Council Regulation (EEC) 2377/90 laying down a Community procedure for the establishment of maximum residue limits of veterinary medicinal products in foodstuffs of animal origin. A definitive MRL (Maximum Residues Limit) has been established.

Active ingredients effective against *Varroa destructor* such as phosphorganic compounds are also clorfenvinfos (Supona<sup>®</sup>, Birlane<sup>®</sup>) and coumaphos (Asuntol<sup>®</sup>), as well as amitraz (TakTic<sup>®</sup>, Bumetran<sup>®</sup>). They are highly effective and easy to be used, but can be toxic to the bees. Furthermore, mites can develop resistance and residues can be found in beeswax as well as in honey. Beekeepers tend to use these products since they are generally cheaper (they are intended for agriculture) and largely available on the market.

The use of these products not intended for bees should be discouraged to guarantee the safety of bees, the quality of beehive products and the safety of beekeepers.

## LIMITS OF TRADITIONAL CHEMICAL TREATMENTS – RESIDUES

Residues can be found in honey (amitraz, cymiazole, which are hydrophilic, but also lipophilic substances such as pyrethroids and phosphorganic compounds). Residues of pyrethroids and phosphorganic compounds can be found more often in beeswax and other beehive products (propolis, pollen) according to their lipophilic properties.

## LIMITS OF TRADITIONAL CHEMICAL TREATMENTS - RESIDUES IN BEESWAX

Data on residues in bee products of traditional chemicals used for varroosis control have been reviewed by Wallner (1999). Those reported by Bogdanov *et al.* (1998) are given as an example:

Bromopropylate (1,600 mg)

1 to 5 treatments

47.9 – 135.0 ppm in brood comb;

Fluvalinate (1,600 mg)

1 to 12.5 months of treatment

1.8 – 43.4 ppm in brood comb;

Coumaphos (32 mg)

1 to 5 treatments

4.3 – 7.4 ppm in brood comb.

## LIMITS OF TRADITIONAL CHEMICAL TREATMENTS PHARMACORESISTANCE –

The presence of Varroa-mites resistant to amitraz is well known (Elzen *et al.*, 2000). Mites resistant to fluvalinate (pyrethroid) were first reported in northern Italy by Spreafico *et al.* (1993) and further investigated by Milani (1995, 1999). The resistance to coumaphos (phosphorganic compound) was described more recently in northern Italy (Spreafico *et al.*, 2001) and in USA (Elzen and Westervelt, 2002).

## INTEGRATED CONTROL OF VARROOSIS

The following interventions allow to obtain a good control of Varroa-mite infestation in the frame of an integrated control strategy. In addition, essential oils and organic acids have a limited impact on honeybee products and are well tolerated by the bees. Easy methods of application have also been developed (Mutinelli *et al.*, 1997; Bollhalder, 1999; Imdorf *et al.*, 1999; Mattila and Otis, 1999; Imdorf *et al.*, 2003).

New treatment concepts are needed to guarantee healthy beehive products. In fact, two treatments a year allow the mite population to reach considerable levels each year and honey bees are treated with hard chemicals repeatedly. New active ingredients are needed. Some are already available and authorised, e.g. thymol. An acaricide that should fulfil new strategy has to be healthy for bee products and unlikely to select resistant mites.

## BROODRIGHT COLONIES

### APILIFE VAR (CHEMICALS LAIF)

Methodology:

- a) low dosage (1 tab broken into 3-4 pieces/week administered 3 times)
- b) full dosage (2 tabs broken into 2-3 pieces for 12 days, then repeat the same administration 1 time)

Time of treatment:

- a) and b) right after the last honey removal in summer

Main advantages:

- a) and b) effective treatments, simple administration
- a) containment of side-effects, treatment-cost reduction

Main disadvantages:

a) and b):

- some variation in efficacy due to different parameters (weather, colony strength, etc.)

b):

- damages on bees and brood under some conditions

- risk of robbing when too hot
- risk of hive abandonment

### **APIGUARD® (VITA EUROPE)**

Methodology:

- a) 1 tray for 21 days, then repeat for other 21 days

Time of treatment:

- a) right after the last honey removal in summer

Main advantages:

- a) effective treatments, easy administration

Main disadvantages:

a)

- brood and food removal soon after the introduction of the tray
- some variation in efficacy due to different parameters (weather, colony strength, etc.)

Thymovar (Andermatt Biocontrol AG)

Methodology:

- a) 1 tissue sponge for 14 days, then repeated for other 14 days

Time of treatment:

- a) right after the last honey removal in summer

Main advantages:

- a) effective treatments, easy administration

Main disadvantages:

a)

- brood and food removal soon after the introduction of the tissue sponge
- some variation in efficacy due to different parameters (weather, colony strength, etc.)

## THYMOL (POWDERED CRYSTALS)

Methodology:

- 0.25 g / comb occupied by bees (max 1.5-2 g/hives) on the top bar of the frame every 4-7 days for 4-5 times

Time of treatment:

- right after the last honey removal in summer

Main advantage:

- effective treatment

Main disadvantages:

- some variation in efficacy due to different parameters (weather, colony strength, etc.)
- damages on bees and brood under some conditions
- risk of queen loss
- risk of hive abandonment

The use of powdered crystals of thymol is recommended only to experienced beekeepers. In fact, its use requires attention and a careful dosage of the active ingredient.

## FORMIC ACID

Methodology:

- treatment right after honey harvest
- 40 ml 85% formic acid soaked pad inserted onto the diagnostic tray (“treatment from below”)

Repeat the administration 4 times at 1-week interval

This dosage is suggested for a mid August or later treatment

- 100 ml 60% formic acid soaked pad placed on the top bar of the frames (“treatment from above”)

Repeat the administration 4 times at 1-week interval

This dosage is suggested when treating hives at the end of July / beginning of August (high temperature)

Too fast evaporation can be prevented by protecting the pad with some plastic sheet

Several devices intended for formic acid evaporation have been developed. However, their application is conditioned by weather conditions and limited mainly to central and northern Europe.

Time of treatment:

- right after the last honey removal in summer

Main advantages:

- cheap treatment
- effect also on mites in sealed brood

Main disadvantages:

- some variation in efficacy due to different parameters (weather, colony strength, etc.)
- damages on bees and brood under some conditions
- risk of queenloss
- risk of hive abandonment
- requires skilled beekeepers

## BROODLESS COLONIES

### OXALIC ACID

Methodology:

- a) 4.2% topical (trickling) application (sugar solution):
  - 10 :100 :100 solution (dehydrated oxalic acid, sugar, water). Actually an other formula has been proposed, 8:40:100, which maintains unaltered the proportion among the different components:
  - 5 ml / in-between comb room occupied by the bees
  - 1 administration. Repeated administrations may be badly tolerated by bees
- b) spraying directly on the bees (in water only):
  - 2% water solution
  - 3 ml / comb side occupied by the bees
  - 1 administration
- c) sublimating within the hive using the VarroX device
  - 2 g/hive/2.5 min, then keep the hive closed for 15 min
  - 1 administration

Time of treatment:

- fall (winter broodless colonies)

Main advantages:

- a) simple, effective and cheap treatment
- b) effective and cheap treatment
- c) effective and cheap treatment

Main disadvantages:

- a) none
- b) and c) labour-intensive, time consuming

## **BROODRIGHT WINTER**

This situation usually occurs in southern Europe.

At present no highly effective ecological alternative for Varroa control in colonies with sealed brood are available. This makes it difficult to conceive a strategy as successful as it can be made during broodless winter conditions. Besides, the great variability in climatic and technical situations makes it impossible to formulate homogeneous recommendations. However some points can be stipulated.

In winter and mid summer the amount of brood in the colonies is usually at its minimum level. This condition can be exploited to maximize the treatment effectiveness. Brood removal can be very helpful in both cases, but difficult to be applied.

Either in winter or in summer Apilife VAR and oxalic acid can be applied according to the local situation. Two treatments may not be enough for sufficient control, therefore further treatment is likely to be needed in most cases, preferably between harvests.

The production of artificial swarms meant for crop pollination or for new colonies production is a significant source of income and also a method that helps controlling the mite populations.

## **CONCLUSIONS**

Varroosis control is needed for the survival of beekeeping. As a consequence, beekeepers are required to adequately manage their bee yards and to apply affordable varroosis control strategies. This implies the use of appropriate products (active ingredients) and timing for treatments in order to avoid residues in honey bee products and the development of pharmacoresistant mites.

It is then necessary to discourage the use of hard chemicals for the control of varroosis.

Furthermore, the co-operation among beekeepers, beekeepers' associations, Veterinary Services, research institutions and Regulatory Authorities is strongly recommended.

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